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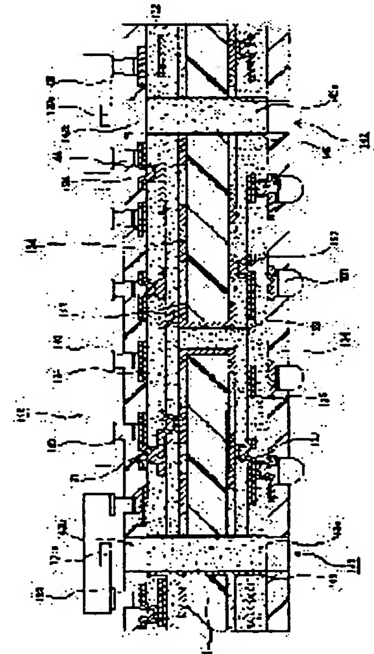
(54) IC CHIP MOUNTING SUBSTRATE, MANUFACTURING METHOD FOR THE SAME, AND OPTICAL COMMUNICATION DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an IC chip mounting substrate wherein an optical communication part in which an IC chip is integrated with an optical part, the distance between the IC chip and the optical part is short, electric signal transmission is performed reliably, and an optical signal is transmitted through an optical signal transmission light path.

SOLUTION: The IC chip mounting substrate is provided where a conductor circuit and an inter-layer resin insulating layer are laminated on both surfaces of the substrate, while a solder resist layer is formed on an outermost layer with an optical element being mounted. It comprises an optical signal transmission light path penetrating itself.



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CLAIMS

[Claim(s)]
[Claim 1] both sides of a substrate — a conductor — the substrate for IC chip mounting characterized by arranging the optical path for lightwave signal transmission which is the substrate for IC chip mounting with which the optical element was mounted, and penetrates said substrate for IC chip mounting while laminating formation of a circuit and the layer insulation layer is carried out and a solder resist layer is formed in the outermost layer.
[Claim 2] Said optical path for lightwave signal transmission is a substrate for IC chip mounting according to claim 1 constituted by the opening.
[Claim 3] Said optical path for lightwave signal transmission is a substrate for IC chip mounting according to claim 1 constituted by the resin constituent and the opening.
[Claim 4] Said optical path for lightwave signal transmission is a substrate for IC chip mounting according to claim 1 constituted by the opening and the conductor layer of the perimeter.
[Claim 5] Said optical path for lightwave signal transmission is a substrate for IC chip mounting according to claim 1 constituted by the resin constituent and the opening, and the conductor layer of these perimeters.
[Claim 6] The mounting position of said optical element is a substrate for IC chip mounting given in any 1 of claims 1-5 which are the front faces of the substrate for IC chip mounting.
[Claim 7] Said optical element is a substrate for IC chip mounting according to claim 6 which are a photo detector and/or a light emitting device.
[Claim 8] The substrate for IC chip mounting given in any 1 of claims 1-7 by which electronic parts are mounted in the front face of said substrate for IC chip mounting.
[Claim 9] The substrate for IC chip mounting given in any 1 of claims 1-8 by which the micro lens is arranged in the edge of said optical path for lightwave signal transmission.
[Claim 10] The path of the cross section of said optical path for lightwave signal transmission is a substrate for IC chip mounting given in any 1 of claims 1-9 which are 100-500 micrometers.
[Claim 11] the conductor said whose substrate was pinched — the conductor said whose layer insulation layer between circuits was connected through the through hole and pinched — the substrate for IC chip mounting given in any 1 of claims 1-10 to which between circuits is connected through the Bahia hall.
[Claim 12] (a) both sides of a substrate — a conductor — the manufacture approach of the substrate for IC chip mounting characterized by to be included the solder-resist layer formation process which forms the solder-resist layer which has opening which was open for free passage to the through tube formed at the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the layer-insulation layer one by one, and is used as a multilayer-interconnection plate, and the process of the through-hole formation process which forms a through tube in said multilayer-interconnection plate, and (b) (c) above (b).

[Claim 13] The manufacture approach of the substrate for IC chip mounting containing the roughening side formation process which makes a roughening side the wall surface of the through tube formed at the process of the above (b) according to claim 12.
[Claim 14] The manufacture approach of the substrate for IC chip mounting according to claim 12 or 13 which contains the conductor-layer formation process which forms a conductor layer in the wall surface of the through tube formed at the process of the above (b).
[Claim 15] The manufacture approach of the substrate for IC chip mounting given in any 1 of claims 12-14 which contain like the resin constituent packer filled up with a non-hardened resin constituent in the through tube formed at the process of the above (b).
[Claim 16] The manufacture approach of the substrate for IC chip mounting given in any 1 of claims 12-15 including the micro-lens arrangement process which arranges a micro lens in the edge of opening formed at the

process of the above (c).
[Claim 17] The device for optical communication which is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board, and is characterized by forming in said substrate for IC chip mounting the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting.
[Claim 18] the device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board — it is — said multilayer printed wiring board — a substrate and a conductor — the device for optical communication which is constituted including the circuit and characterized by forming in said multilayer printed wiring board the optical path for lightwave signal transmission which penetrates a substrate at least.
[Claim 19] the optical path for lightwave-signal transmission which is the device for optical communication which consists of a substrate for IC chip mounting and a multilayer printed wiring board, and penetrates this substrate for IC chip mounting to said substrate for IC chip mounting forms — having — **** — said multilayer printed wiring board — a substrate and a conductor — the device for optical communication which is constituted including a circuit and characterized by to be formed the optical path for lightwave-signal transmission which penetrates a substrate at least in said multilayer printed wiring board.
[Claim 20] Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 17-19 constituted by the opening.
[Claim 21] Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 17-19 constituted by the resin constituent and the opening.
[Claim 22] Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 17-19 constituted by the opening and the conductor layer of the perimeter.
[Claim 23] Said optical path for lightwave signal transmission is a device for optical communication given in any 1 of claims 17-19 constituted by the resin constituent and the opening, and the conductor layer of these perimeters.
[Claim 24] The substrate for IC chip mounting given in any 1 of claims 17-23 by which the micro lens is arranged in the edge of said optical path for lightwave signal transmission.
[Claim 25] The path of the cross section of said optical path for lightwave signal transmission is a substrate for IC chip mounting given in any 1 of claims 17-24 which are 100-500 micrometers.
[Claim 26] It is a substrate for IC chip mounting given in any 1 of claims 17-25 whose mounting positions of said optical element the optical element is mounted in said substrate for IC chip mounting, and are the front faces of the substrate for IC chip mounting.
[Claim 27] Said optical element is a substrate for IC chip mounting according to claim 26 which are a photo detector and/or a light emitting device.
[Claim 28] said substrate for IC chip mounting — a conductor — the conductor the circuit, the layer insulation layer, and said whose layer insulation layer were pinched — the device for optical communication given in any 1 of claims 17-27 constituted including the Bahia hall which connects between circuits.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the substrate for IC chip mounting, and the substrate for IC chip mounting, and the device for optical communication.
[0002]
[Description of the Prior Art] In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed. In the communication system using the optical fiber which has the descriptions, such as ** low loss, ** high bandwidth, ** narrow diameter and a light weight, no ** guiding, and ** saving resources, and has this description, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced substantially, construction and maintenance become easy, and an optical fiber can attain economization of communication system, and high-reliability-ization.
[0003] Moreover, since an optical fiber can multiplex simultaneously the light of the wavelength from which not only the light of one wavelength but many differ with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004] Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed.
[0005] Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., in order for IC which performs information (signal) processing in a terminal equipment to operate with an electrical signal, it is necessary to attach the equipment (henceforth light/electric transducer) which changes the lightwave signal and electrical signal of optical -> electric transducer, electric -> phototransducer, etc. into a terminal equipment. So, in the conventional terminal equipment, for example, optical elements, such as a package substrate which mounted IC chip, a photo detector which processes a lightwave signal, and a light emitting device, etc. were mounted independently, electric wiring and optical waveguide were connected to these, and a signal transmission and signal processing were performed. Moreover, performing optical communication of a terminal equipment using the package substrate (henceforth a package substrate with a built-in optical element) which was made to contain optical elements, such as a photo detector, in the interior of the package substrate which mounted IC chip, and contained this optical element is also proposed.
[0006]
[Problem(s) to be Solved by the Invention] In such a conventional terminal equipment, when optical elements, such as a package substrate which mounted IC chip, a photo detector which processes a lightwave signal, and a light emitting device, etc. were mounted independently, it was difficult for equipment itself to become large and to achieve the miniaturization of a terminal equipment. Moreover, the optical element was built in, and although the problem that equipment itself became large was solved when the substrate for IC chip mounting with which IC chip was mounted was used, there was the following inconvenience.
[0007] That is, in the package substrate with a built-in optical element, it was difficult to tune alignment finely, in case it connects with external optical elements (an optical fiber, optical waveguide, etc.), since the optical element is thoroughly built in in the substrate, and since the optical element was beforehand built in in case a package substrate is manufactured, it was easy to generate a location gap of an optical element. In the production process of a package substrate, this is considered that a location gap of an optical element occurs at the time of this heat treatment, when it is necessary to perform heat treatment etc. and builds an optical element in a resin layer. Thus, when a location gap occurred in the built-in optical element, it was large and the

connection loss at the time of connecting with an external optic (for example, optical waveguide) was led to lowering of the connection dependability in optical communication. Moreover, since it was not able to exchange only that optical element but that package substrate with a built-in optical element itself served as a defective when inconvenience occurs in either of the built-in optical elements in this package substrate with a built-in optical element, it was economically disadvantageous. Moreover, the mounting position of an optical element will be restricted by reservation of the optical path for lightwave signal transmission, and the physical relationship of an optical element and the optics (optical waveguide etc.) attached in the external substrate, therefore the densification of the substrate for IC chip mounting might become difficult.
[0008]
[Means for Solving the Problem] Then, while this invention persons attain the optical communication which is excellent in connection dependability By establishing the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting to the substrate for IC chip mounting, as a result of examining wholeheartedly the substrate for IC chip mounting which can be contributed to the miniaturization of a terminal equipment It hit on an idea for the technical problem mentioned above to be solvable, and the substrate for IC chip mounting of this invention which consists of the following configuration was completed. Furthermore, in the device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board, while securing the lightwave signal transmission nature which was excellent by forming the optical path for lightwave signal transmission in either in a predetermined mode at least with the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, the header and the device for optical communication of this invention were completed for the ability of high density wiring to be attained.
[0009] namely, the substrate for IC chip mounting of the first this invention — both sides of a substrate — a conductor — while laminating formation of a circuit and the layer insulation layer is carried out and a solder resist layer is formed in an outermost layer of drum, it is characterized by arranging the optical path for lightwave signal transmission which is the substrate for IC chip mounting with which the optical element was mounted, and penetrates the above-mentioned substrate for IC chip mounting.
[0010] As for the above-mentioned optical path for lightwave signal transmission, in the substrate for IC chip mounting of the first this invention, it is desirable to be constituted by the opening or to be constituted by the resin constituent and the opening.
[0011] Moreover, as for the above-mentioned optical path for lightwave signal transmission, in the substrate for IC chip mounting of the first this invention, it is also desirable to be constituted by the opening and the conductor layer of the perimeter, or to be constituted by the resin constituent and the opening, and the conductor layer of these perimeters.
[0012] Moreover, in the above-mentioned substrate for IC chip mounting, as for the mounting position of the above-mentioned optical element, it is desirable that it is the front face of the substrate for IC chip mounting, and, as for the above-mentioned optical element, it is desirable that they are a photo detector and/or a light emitting device. Moreover, it is desirable to mount electronic parts in the front face of the above-mentioned substrate for IC chip mounting.
[0013] Moreover, in the above-mentioned substrate for IC chip mounting, it is desirable to arrange the micro lens in the edge of the above-mentioned optical path for lightwave signal transmission, and, as for the path of the cross section of the above-mentioned optical path for lightwave signal transmission, it is desirable that it is 100-500 micrometers.
[0014] moreover, the conductor whose above-mentioned substrate was pinched in the above-mentioned substrate for IC chip mounting — the conductor whose above-mentioned layer insulation layer between circuits was connected through the through hole and pinched — it is desirable to connect between circuits through the Bahia hall.
[0015] Moreover, the manufacture approach of the substrate for IC chip mounting of the second this invention (a) — both sides of a substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the layer insulation layer one by one, and is used as a multilayer-interconnection plate (b) It is characterized by including the solder resist layer formation process which forms the solder resist layer which has opening which was open for free passage to the breakthrough formed at the through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the process of (c) above (b).
[0016] As for the manufacture approach of the above-mentioned substrate for IC chip mounting, it is desirable to include the roughening side formation process which makes a roughening side the wall surface of the breakthrough formed at the process of the above (b). Moreover, as for the manufacture approach of the above-mentioned substrate for IC chip mounting, it is desirable to include the conductor-layer formation process which

forms a conductor layer in the wall surface of the breakthrough formed at the process of the above (b).
[0017] Moreover, as for the manufacture approach of the above-mentioned substrate for IC chip mounting, it is desirable to include the resin constituent restoration process filled up with a non-hardened resin constituent in the breakthrough formed at the process of the above (b). Moreover, as for the manufacture approach of the above-mentioned substrate for IC chip mounting, it is desirable to include the micro-lens arrangement process which arranges a micro lens in the edge of opening formed at the process of the above (c).
[0018] The device for optical communication of the third this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board, and is characterized by forming in the above-mentioned substrate for IC chip mounting the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting.
[0019] the device for optical communication with which the device for optical communication of the fourth this invention consists of a substrate for IC chip mounting, and a multilayer printed wiring board — it is — the above-mentioned multilayer printed wiring board — a substrate and a conductor — it is constituted including the circuit and characterized by forming in the above-mentioned multilayer printed wiring board the optical path for lightwave signal transmission which penetrates a substrate at least.
[0020] The device for optical communication of the fifth this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board. To the above-mentioned substrate for IC chip mounting the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting forms — having — **** — the above-mentioned multilayer printed wiring board — a substrate and a conductor — it is constituted including the circuit and characterized by forming in the above-mentioned multilayer printed wiring board the optical path for lightwave signal transmission which penetrates a substrate at least.
[0021] As for the above-mentioned optical path for lightwave signal transmission, in the device for optical communication of the third - the fifth this invention, it is desirable to be constituted by the opening or to be constituted by the resin constituent and the opening.
[0022] Moreover, as for the above-mentioned optical path for lightwave signal transmission, in the device for optical communication of the third - the fifth this invention, it is also desirable to be constituted by the opening and the conductor layer of the perimeter, or to be constituted by the resin constituent and the opening, and the conductor layer of these perimeters.
[0023] Moreover, in the above-mentioned device for optical communication, it is desirable to arrange the micro lens in the edge of the above-mentioned optical path for lightwave signal transmission. Moreover, as for the path of the cross section of the above-mentioned optical path for lightwave signal transmission, in the above-mentioned device for optical communication, it is desirable that it is 100-500 micrometers.
[0024] Moreover, in the above-mentioned device for optical communication, the optical element is mounted in the above-mentioned substrate for IC chip mounting, and, as for the mounting position of the above-mentioned optical element, it is desirable that it is the front face of the substrate for IC chip mounting. As for the above-mentioned optical element, it is desirable that they are a photo detector and/or a light emitting device.
[0025] moreover, the above-mentioned device for optical communication — setting — the above-mentioned substrate for IC chip mounting — a conductor — the conductor the circuit, the layer insulation layer, and whose above-mentioned layer insulation layer were pinched — it is desirable to be constituted including the Bahia hall which connects between circuits.
[0026]
[Embodiment of the Invention] Hereafter, the substrate for IC chip mounting of the first this invention is explained. the substrate for IC chip mounting of the first this invention — both sides of a substrate — a conductor — while laminating formation of a circuit and the layer insulation layer is carried out and a solder resist layer is formed in an outermost layer of drum, it is characterized by arranging the optical path for lightwave signal transmission which is the substrate for IC chip mounting with which the optical element was mounted, and penetrates the above-mentioned substrate for IC chip mounting.
[0027] Since the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged while an optical element is mounted, the substrate for IC chip mounting of the first this invention can transmit the I/O signal of the above-mentioned optical element through the above-mentioned optical path for lightwave signal transmission.
[0028] Moreover, when IC chip is mounted in this substrate for IC chip mounting, the distance of IC chip and an optical element is short, and it excels in the dependability of electrical signal transmission. When an optical element is a photo detector, a mass lightwave signal can specifically be processed correctly and quickly, and when an optical element is a light emitting device, the lightwave signal to the exterior can be sent promptly. Moreover, in the substrate for IC chip mounting of the first this invention which mounted IC chip, since

electronic parts and an optical element required for optical communication can be unified, it can contribute to the miniaturization of the terminal equipment for optical communication.

[0029] moreover, the case where the surface mount of the optical element is carried out — the conductor of the above-mentioned substrate for IC chip mounting — since an optical element is mounted after forming a circuit and a layer insulation layer — this — a conductor — the optical element has not been mounted at the time of heat treatment at the time of forming a circuit, a layer insulation layer, etc., and the location gap which may take place at the time of heat treatment is not generated at it Furthermore, it is [that what is necessary is to exchange only the optical element] economically advantageous, when the surface mount of the optical element is carried out and inconvenience occurs in the optical element of 1.

[0030] Moreover, in the substrate for IC chip mounting of the first this invention, since optical processing and a mechanical process can perform alignment of this optical element on the basis of the optical path for lightwave signal transmission in case an optical element is mounted, an optical element can be correctly mounted in a desired location.

[0031] Moreover, in the substrate for IC chip mounting of the first this invention in which an optical path for lightwave signal transmission which was mentioned above is formed, when it mounts an optical element, the degree of freedom of the mounting position of this optical element will increase, and the densification of wiring of the substrate for IC chip mounting can be achieved. This is because a free space becomes large in the design of the substrate for IC chip mounting, when the degree of freedom of the mounting position of an optical element increases. in addition, the above-mentioned free space — a conductor — the field which forms a circuit or mounts electronic parts, such as a capacitor, is said.

[0032] In the substrate for IC chip mounting of the first this invention, the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged. In the substrate for IC chip mounting in which such an optical path for lightwave signal transmission was arranged, a lightwave signal can perform transfer of the information on the optical elements mounted in both sides of the above-mentioned substrate for IC chip mounting through this optical path for lightwave signal transmission. Moreover, in the above-mentioned substrate for IC chip mounting, a lightwave signal can perform transfer of the information between the optical element mounted in the substrate for IC chip mounting of the first this invention, and the optical element mounted in the above-mentioned external substrate through the optical path for lightwave signal transmission by carrying out the surface mount of the optical element to the field side of 1, and connecting other field side through an external substrate, solder, etc. which mounted another optical element.

[0033] As for the above-mentioned optical path for lightwave signal transmission, to be constituted by the opening is desirable. When the optical path for lightwave signal transmission is formed of the opening, while the formation is easy, in transmission of the lightwave signal through this optical path for lightwave signal transmission, it is hard to generate transmission loss. In addition, in consideration of the thickness of the substrate for IC chip mounting etc., it should just determine suitably whether the configuration of the above-mentioned optical path for lightwave signal transmission is made into an opening.

[0034] Moreover, as for the above-mentioned optical path for lightwave signal transmission, to be constituted by the resin constituent and the opening is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent and the opening, lowering of the reinforcement of the substrate for IC chip mounting can be prevented. In addition, when the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent and the opening, it is desirable for the optical path for lightwave signal transmission formed in the part which penetrates a substrate and a layer insulation layer to be constituted by the resin constituent, and for the optical path for lightwave signal transmission formed in the solder resist layer to be constituted by the opening. Usually, a substrate and a layer insulation layer have high adhesion with resin, and a solder resist layer is because adhesion with resin is low.

[0035] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted with the resin constituent is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent, lowering of the reinforcement of the substrate for IC chip mounting can be prevented. Moreover, if the optical path for lightwave signal transmission is constituted by the resin constituent, since it can prevent that dust, a foreign matter, etc. enter in this optical path for lightwave signal transmission, it can prevent that originate in existence of dust, a foreign matter, etc. and transmission of a lightwave signal is checked.

[0036] Moreover, in the optical path for lightwave signal transmission which consists of the optical path for lightwave signal transmission, i.e., the opening, and resin constituents of a configuration as mentioned above, it is hard to generate the adverse effect (for example, for the path of the cross section of the optical path for lightwave signal transmission to become small) by heat etc. in the bottom of a heat treatment process or a reliability trial.

[0037] When a part or all of the above-mentioned optical path for lightwave signal transmission consists of resin constituents, the resin with which it was not limited as the resinous principle especially when there was little absorption by the communication link wavelength range, for example, some of thermosetting resin, thermoplastics, photopolymers, and thermosetting resin were photosensitivity-ized is mentioned. Specifically, silicone resin, such as polyimide resin, such as acrylic resin, such as an epoxy resin, UV hardenability epoxy resin, polyolefine system resin, PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, and fluorination polyimide, and deuteration silicone resin, the polymer manufactured from benz-cyclo-butene are mentioned.

[0038] Moreover, particles, such as for example, a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned resin constituent in addition to the above-mentioned resinous principle. By including these particles, adjustment of a coefficient of thermal expansion can be aimed at between the optical path for lightwave signal transmission, a substrate, a layer insulation layer, a solder resist layer, etc., and fire retardancy can also be given depending on the class of particle. As the above-mentioned resin particle, the resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, the complex of a photopolymer and thermoplastics, etc. are mentioned, for example.

[0039] Specifically For example, an epoxy resin, phenol resin, polyimide resin, Thermosetting resin, such as a bismaleimide resin, polyphenylene resin, polyolefin resin, and a fluororesin; The heat-curing radical of these thermosetting resin A methacrylic acid, an acrylic acid, etc. are made to react to (for example, the epoxy group in an epoxy resin). Resin which gave the acrylic radical; Phenoxy resin, polyether sulfone (PES), Thermoplastics, such as polysulfone (PSF), a polyphenylene sulfone (PPS), polyphenylene sulfide (PPES), a polyphenyl ether (PPE), and polyether imide (PI); photopolymers, such as acrylic resin, etc. are mentioned. Moreover, the resin complex of the resin complex of the above-mentioned thermosetting resin and the above-mentioned thermoplastics, the resin which gave the above-mentioned acrylic radical, the above-mentioned photopolymer, and the above-mentioned thermoplastics can also be used. Moreover, the resin particle which consists of rubber can also be used as the above-mentioned resin particle.

[0040] Moreover, as the above-mentioned inorganic particle, titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, and basic magnesium carbonate, a silica, and a zeolite, and a titania, etc. are mentioned, for example. Moreover, what consists of Lynn or phosphorus compounds can also be used as the above-mentioned inorganic particle.

[0041] As the above-mentioned metal particles, Au, Ag, Cu, Pd, nickel, Pt, Fe, Zn, Pb, aluminum, Mg, calcium, Ti, etc. are mentioned, for example. These resin particles, an inorganic particle, and the particle of metal particles may be used independently, respectively, and may be used together two or more sorts.

[0042] Moreover, especially the configuration of particles, such as the above-mentioned resin particle, is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. Moreover, as for the particle size (the die length of the longest part of a particle) of the above-mentioned particle, it is desirable that it is shorter than communication link wavelength. It is because transmission of a lightwave signal may be checked when particle size is longer than communication link wavelength.

[0043] Moreover, especially the configuration of the above-mentioned optical path for lightwave signal transmission is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned. In these, the shape of a cylinder is desirable. It is because the formation is easy.

[0044] Moreover, a minimum with the desirable path of the cross section of the above-mentioned optical path for lightwave signal transmission is 100 micrometers, and a desirable upper limit is 500 micrometers. While there is a possibility that an optical path may be closed for the path of the above-mentioned cross section by less than 100 micrometers, when this a part of optical path [at least] for lightwave signal transmission consists of resin constituents, it is difficult to be filled up with a non-hardened resin constituent. the conductor which whose transmission nature of a lightwave signal seldom improves on the other hand even if it makes the path of the above-mentioned cross section larger than 500 micrometers, but constitutes the substrate for IC chip mounting — it is because it may become the cause which checks the degree of freedom of designs, such as a circuit. A minimum is 250 micrometers and the upper limit of the path of a more desirable cross section is 350 micrometers. It is because inconvenience does not occur also in case both the transmission nature of a lightwave signal and the degree of freedom of a design are excellent and it is filled up with a non-hardened resin constituent. In addition, in the case of the shape of the diameter of the cross section, and an elliptic cylinder, in

the case of the shape of the shape of the major axis of the cross section, and the square pole, or a multiple column, the path of the cross section of the above-mentioned optical path for lightwave signal transmission means the die length of the longest part of the cross section, when the above-mentioned optical path for lightwave signal transmission is a cylinder-like.

[0045] As for the above-mentioned optical path for lightwave signal transmission, it is desirable to consist of an opening and a conductor layer of the perimeter. Moreover, as for the above-mentioned optical path for lightwave signal transmission, it is also desirable to consist of a resin constituent and a conductor layer of the perimeter. Moreover, as for the above-mentioned optical path for lightwave signal transmission, it is also desirable to consist of a resin constituent and an opening, and a conductor layer of these perimeters. In addition, when the above-mentioned conductor layer is formed, this conductor layer may be formed in a resin constituent and/or the whole perimeter of an opening, and may be formed in a part of perimeter.

[0046] Thus, by forming a conductor layer in the optical path for lightwave signal transmission, the scattered reflection of the light in the wall surface of the optical path for lightwave signal transmission can be reduced, and the transmission nature of a lightwave signal can be raised. The above-mentioned conductor layer may be formed from one layer, and may consist of more than two-layer. As an ingredient of the above-mentioned conductor layer, copper, nickel, chromium, titanium, noble metals, etc. are mentioned, for example. moreover, the conductor with which the above-mentioned conductor layer sandwiched the duty as a through hole, i.e., a substrate, depending on the case — the conductor between circuits, and whose substrate and layer insulation layer were pinched — the duty which connects between circuits electrically can be achieved.

[0047] As an ingredient of the above-mentioned conductor layer, the metal which has the gloss of nickel, noble metals, etc. is desirable. It is because there is more little loss of a lightwave signal, and it is also rarer to check transmission of a lightwave signal, when the conductor layer which consists of a metal which has gloss is formed, so a lightwave signal will be more certainly transmitted through the optical path for lightwave signal transmission.

[0048] Moreover, the enveloping layer and roughening layer which consist of tin, titanium, zinc, etc. may be further prepared on the above-mentioned conductor layer. It may be desirable to stop the scattered reflection of the light in the wall surface of the optical path for lightwave signal transmission depending on the classes (wavelength etc.) of lightwave signal transmitted through the optical path for lightwave signal transmission, and the transmission nature of a lightwave signal may be raised by preparing the above-mentioned enveloping layer and the above-mentioned roughening layer, and reducing the scattered reflection of the light in this wall surface. Moreover, the adhesion of the optical path for lightwave signal transmission, and a substrate and a layer insulation layer can be raised more by forming the above-mentioned roughening layer etc. in the wall surface of the optical path for lightwave signal transmission.

[0049] moreover, the optical path for lightwave signal transmission (the resin constituent of the optical paths for lightwave signal transmission constituted with an opening and a resin constituent — ** — a part is included) and the above-mentioned conductor layer which are constituted with the above-mentioned resin constituent may be in contact with the substrate or the layer insulation layer through the roughening side. It is because it excels in adhesion with a substrate or a layer insulation layer and is harder to generate exfoliation of the optical path for lightwave signal transmission etc., when the above-mentioned optical path for lightwave signal transmission etc. has touched through the roughening side.

[0050] In the above-mentioned substrate for IC chip mounting, as the above-mentioned optical path for lightwave signal transmission, the optical path for lightwave signal transmission for light-receiving, the optical path for lightwave signal transmission for luminescence, and both may be formed, and only either may be formed. Therefore, in the above-mentioned substrate for IC chip mounting, two or more optical paths for lightwave signal transmission may be formed. the lightwave signal from the outside where the above-mentioned optical path for lightwave signal transmission for light-receiving has been transmitted through an optical fiber, optical waveguide, etc. — a photo detector — ** — in order to transmit the lightwave signal which is for telling and was sent from the light emitting device with the above-mentioned optical path for lightwave signal transmission for luminescence to an external optical fiber, optical waveguide, etc. — it is . Moreover, in the above-mentioned substrate for IC chip mounting, the optical path for lightwave signal transmission may be formed for every communication link wavelength.

[0051] Moreover, optical elements, such as a photo detector and a light emitting device, are mounted in the substrate for IC chip mounting of the first this invention. As the above-mentioned photo detector, PD (photodiode), APD (avalanche photodiode), etc. are mentioned, for example. What is necessary is just to use these properly suitably in consideration of the configuration of the above-mentioned substrate for IC chip mounting, demand characteristics, etc. Si, germanium, InGaAs, etc. are mentioned as an ingredient of the above-mentioned photo detector. In these, a point to InGaAs which is excellent in light-receiving sensibility is desirable.

As the above-mentioned photo detector, PD (photodiode), APD (avalanche photodiode), etc. are mentioned, for example. What is necessary is just to use these properly suitably in consideration of the configuration of the above-mentioned substrate for IC chip mounting, demand characteristics, etc. Si, germanium, InGaAs, etc. are mentioned as an ingredient of the above-mentioned photo detector. In these, a point to InGaAs which is excellent in light-receiving sensibility is desirable.

[0052] As the above-mentioned light emitting device, LD (semiconductor laser), DFB-LD (distribution feedback mold-semiconductor laser), LED (light emitting diode), etc. are mentioned, for example. What is necessary is just to use these properly suitably in consideration of a configuration, demand characteristics, etc. of the above-mentioned substrate for IC chip mounting.

[0053] As an ingredient of the above-mentioned light emitting device, a gallium, arsenic and the compound (GaAsP) of Lynn, a gallium, aluminum and the compound (GaAlAs) of arsenic, a gallium and the compound (GaAs) of arsenic, an indium, a gallium and the compound (InGaAs) of arsenic, an indium, a gallium, arsenic, the compound (InGaAsP) of Lynn, etc. are mentioned. That what is necessary is just to use these properly in consideration of communication link wavelength, when communication link wavelength is 0.85-micrometer band, GaAlAs can be used, and in the case of 1.3-micrometer band or 1.55-micrometer band, communication link wavelength can use InGaAs and InGaAsP.

[0054] Moreover, as for the mounting position of the above-mentioned optical element, it is desirable that it is the front face of the substrate for IC chip mounting. As mentioned above, when the optical element is mounted in the front face of the substrate for IC chip mounting and inconvenience occurs in the optical element of 1, it is because what is necessary is to exchange only the optical element. The above-mentioned optical element has the desirable thing of a flip chip mold. The exchange is easy and it is because it is easy to mount according to a self-alignment operation in a desired location at the time of mounting. Moreover, if the mounting position of an optical element is the front face of the substrate for IC chip mounting, as mentioned above, alignment of an optical element can be performed for the optical path for lightwave signal transmission at a zero.

[0055] Furthermore, when the mounting position of an optical element is the front face of the substrate for IC chip mounting, the problem generated with the conventional package substrate with a built-in optical element that a location gap of an optical element occurs can be avoided. In the conventional substrate for IC chip mounting, the area which mounts optical elements, such as a photo detector and a light emitting device, was beforehand formed in the substrate, and after attaching an optical element in this substrate, the optical element was mounted by filling up with and hardening embedding resin etc. When an optical element is mounted by such approach, a location gap tended to generate this optical element under the effect of the stress resulting from the curvature of the heat and substrate which win popularity in the cases, such as hardening processing of a layer insulation layer or a solder resist layer, and reflow processing of soldering paste, or the splash at the time of plating processing etc. Furthermore, when mounting of an optical element was performed using adhesives or solder, by the heat history of an after process, this adhesives and solder might become soft and the location gap of an optical element might occur in connection with this. However, when an optical element is mounted in the front face of the substrate for IC chip mounting, the problem which such stress and a location gap generate can be avoided. Compared with the conventional thing, it is because the reinforcement of the substrate for IC chip mounting is maintained.

[0056] In addition, when it mounts an optical element in the front face of the substrate for IC chip mounting, the field which mounts an optical element may be the same field as the field which mounts IC chip, and this may be the field of an opposite hand. Moreover, when it mounts two or more optical elements in the substrate for IC chip mounting, all do not need to be mounted in the same field.

[0057] Moreover, electronic parts, such as a capacitor, may also be mounted in the front face of the above-mentioned substrate for IC chip mounting. It is because only the components which inconvenience generated can be exchanged like the case of the above-mentioned optical element.

[0058] moreover, the conductor whose substrate was pinched in the above-mentioned substrate for IC chip mounting — the conductor said whose layer insulation layer between circuits was connected through the through hole and pinched — it is desirable to connect between circuits through the Bahia hall. It is because the densification of the substrate for IC chip mounting can be achieved. furthermore, a conductor — it is because the stress which originated in the difference of coefficients of thermal expansion, such as IC chip and an optical element, and was generated can be eased by choosing the formation location of a circuit or the Bahia hall suitably.

[0059] Next, the operation gestalt of the substrate for IC chip mounting of the first this invention is explained, referring to a drawing. Drawing 1 is the sectional view showing typically 1 operation gestalt of the substrate for IC chip mounting of the first this invention. In addition, drawing 1 shows the substrate for IC chip mounting in the condition that IC chip was mounted.

[0060] it is shown in drawing 1 — as — the mounting substrate 120 for IC chip — both sides of a substrate 121 — a conductor — the conductor with which laminating formation was carried out and the substrate 121 of the layer insulation layer [a circuit 124 and] 122 was pinched — the conductor whose layer insulation layer 122 was pinched between circuits — the through hole 129 and the Bahia hall 127 connect electrically between circuits, respectively. Moreover, the solder resist layer 134 is formed in the outermost layer of drum.
[0061] moreover — this mounting substrate 120 for IC chip — a conductor — the optical path 142 for lightwave signal transmission which penetrates the substrate 121 with which the circuit 124, the layer insulation layer 122, and the solder resist layer 134 were formed is formed, and the optical path 142 for lightwave signal transmission consists of resin constituent 142a and opening 142b, and a conductor layer 145 formed in that perimeter. The I/O signal of the optical element (a photo detector 138 and light emitting device 139) mounted in the substrate 120 for IC chip mounting will be transmitted through the optical path for lightwave signal transmission. In addition, the optical path for lightwave signal transmission may be formed with the opening or the resin constituent, and the conductor layer does not need to be formed in the perimeter.
[0062] While the surface mount of a photo detector 138 and the light emitting device 139 is carried out through the solder connection 144 so that each of light sensing portion 138a and light-emitting part 139a may counter the optical path 142 for lightwave signal transmission, the surface mount of the IC chip 140 is carried out to the field of 1 of the mounting substrate 120 for IC chip through the solder connection 143. Moreover, the solder bump 137 is formed in the solder resist layer 134 of other fields of the substrate 120 for IC chip mounting.
[0063] In the substrate 120 for IC chip mounting which consists of such a configuration, the lightwave signal sent from the outside through an optical fiber, optical waveguide (not shown), etc. After receiving by the photo detector 138 (light sensing portion 138a) through the optical path 142 for lightwave signal transmission, it changes into an electrical signal by the photo detector 138 — having — further — the solder connections 143 and 144 and a conductor — it will be sent to the IC chip 140 through a circuit 124, the Bahia hall 127, and through hole 129 grade.
[0064] moreover, the electrical signal sent out from the IC chip 140 — the solder connections 143 and 144 and a conductor — after being sent to a light emitting device 139 through a circuit 124, the Bahia hall 127, and through hole 129 grade, the lightwave signal which it was changed into the lightwave signal by the light emitting device 139, and was sent from the light emitting device 139 (light-emitting part 139a) will be sent out to external optical elements (an optical fiber, optical waveguide, etc.) through the optical path 142 for lightwave signal transmission.
[0065] In the substrate for IC chip mounting of the first this invention, in the photo detector and light emitting device which were mounted in the location near IC chip, since light / electrical signal conversion is performed, the transmission distance of an electrical signal is short, is excellent in the dependability of a signal transmission, and can respond to a high-speed communication link more.
[0066] Moreover, in the substrate 120 for IC chip mounting, since the solder bump 137 is formed in the solder resist layer 134, as mentioned above, after the electrical signal sent out from IC chip is changed into a lightwave signal, it it is not only sent out outside, but will be sent to an external substrate through a solder bump through the optical-path 142 grade for lightwave signal transmission.
[0067] Thus, when the solder bump is formed, the above-mentioned substrate for IC chip mounting can be connected with an external substrate through a solder bump, and the above-mentioned substrate for IC chip mounting can be arranged to a position in this case according to the self-alignment operation which solder has.
[0068] In addition, in order that, as for the above-mentioned self alignment operation, a solder resist layer may crawl solder, solder says the operation to which it is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity which self has at the time of reflow processing. Though location gap has occurred to both in front of a reflow in case the above-mentioned substrate for IC chip mounting is connected to an external substrate through the above-mentioned solder bump when this self-alignment operation is used, the above-mentioned substrate for IC chip mounting can move at the time of a reflow, and this substrate for IC chip mounting can be attached in the exact location on an external substrate. Therefore, if the mounting position of the photo detector mounted in the above-mentioned substrate for IC chip mounting in the photo detector and light emitting device which were mounted in the above-mentioned substrate for IC chip mounting, and the external optical element when a lightwave signal was transmitted through the optical path for lightwave signal transmission, or a light emitting device is exact, an exact lightwave signal can be transmitted between the above-mentioned substrate for IC chip mounting, and the above-mentioned external substrate.
[0069] Moreover, it is desirable to arrange the micro lens in the edge of the above-mentioned optical path for lightwave signal transmission in the substrate for IC chip mounting of the first this invention. It is because the transmission loss of a lightwave signal can be suppressed more.

[0070] It is not limited especially as the above-mentioned micro lens, but what is usually used for the optical lens is mentioned, and optical glass, the resin for optical lenses, etc. are mentioned as an example of the construction material. The same thing as the polymer ingredient used for optical waveguides mentioned later, such as acrylic resin and an epoxy resin, as the above-mentioned resin for optical lenses, for example etc. is mentioned.
[0071] It explains referring to a drawing hereafter about the substrate for IC chip mounting with which the micro lens was arranged in the edge of the optical path for lightwave signal transmission. Drawing 2 is the sectional view showing typically 1 another operation gestalt of the substrate for IC chip mounting of the first this invention. In addition, drawing 2 shows the substrate for IC chip mounting in the condition that IC chip was mounted. In the substrate 1120 for IC chip mounting shown in drawing 2 , micro lenses 146a and 146b are arranged in the edge of the optical path 142 for lightwave signal transmission which consists of resin constituent 142a and opening 142b, and a conductor layer 145 through the binder layers 147a and 147b. Thus, the transmission loss of a lightwave signal can be suppressed by arranging a micro lens. In addition, the operation gestalt of the substrate 1120 for IC chip mounting is the same as the operation gestalt of the substrate 120 for IC chip mounting shown in drawing 1 except having arranged micro lenses 146a and 146b.
[0072] Moreover, although micro-lens 146b which counters a light emitting device 139 is arranged in the light emitting device 139 side of the optical path 142 for lightwave signal transmission in the substrate 1120 for IC chip mounting, the arrangement locations of a micro lens may be the light emitting device 139 side of the optical path 142 for lightwave signal transmission, and an opposite hand. In addition, as for micro-lens 146a which counters a photo detector 138, it is desirable like drawing 2 to be arranged in an opposite hand the photo detector 138 side of the optical path 142 for lightwave signal transmission.
[0073] In addition, when a micro lens is arranged by the optical path for lightwave signal transmission which the arrangement location of a micro lens is not necessarily limited to the edge of the optical path for lightwave signal transmission, for example, consists of a resin constituent and an opening or a resin constituent and an opening, and a conductor layer of these perimeters, the arrangement location may be the edge of a resin constituent. In this case, the arrangement location of a micro lens may serve as the interior of the optical path for lightwave signal transmission. The substrate for IC chip mounting of the first this invention which consists of such a configuration can be manufactured using the manufacture approach of the substrate for IC chip mounting of the second this invention.
[0074] Next, the manufacture approach of the substrate for IC chip mounting of the second this invention is explained. The manufacture approach of the substrate for IC chip mounting of the second this invention (a) — both sides of a substrate — a conductor — with the multilayer-interconnection plate production process which carries out laminating formation of a circuit and the layer insulation layer one by one, and is used as a multilayer-interconnection plate (b) It is characterized by including the solder resist layer formation process which forms the solder resist layer which has opening which was open for free passage to the breakthrough formed at the through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, and the process of (c) above (b).
[0075] In the substrate for IC chip mounting manufactured by the manufacture approach of the second this invention In order that opening which was open for free passage to the breakthrough formed at the above-mentioned (b) process and the breakthrough formed at the process of the above (c) may play a role of an optical path for lightwave signal transmission, The substrate for IC chip mounting of the first this invention, i.e., the substrate for IC chip mounting which transmits the I/O signal of an optical element through the optical path for lightwave signal transmission which penetrates the substrate for IC chip mounting, can be manufactured suitably.

[0076] First, the process of the above (a), i.e., the multilayer-interconnection plate production process which manufactures a multilayer-interconnection plate, is explained in order of a process. Specifically, a multilayer-interconnection plate can be manufactured by passing through the process of following the (1) - (9).
(1) an insulating substrate — a start ingredient — carrying out — first — this insulating substrate top — a conductor — form a circuit. As the above-mentioned insulating substrate, a glass epoxy group plate, a polyester substrate, a polyimide substrate, a bismaleimide-triazine (BT) resin substrate, a thermosetting polyphenylene ether substrate, copper clad laminate, a RCC substrate, etc. are mentioned, for example. Moreover, ceramic substrates, such as an alumimium nitride substrate, and a silicon substrate may be used. the above — a conductor — a circuit can be formed by performing etching processing, after forming a solid conductor layer in the front face of for example, the above-mentioned insulating substrate by nonelectrolytic plating processing etc. Moreover, you may form by performing etching processing to copper clad laminate or a RCC substrate.
[0077] moreover, the conductor whose above-mentioned insulating substrate was pinched — in making connection between circuits by the through hole, after using a drill, laser, etc. for example, for the above-

mentioned insulating substrate and forming the breakthrough for through holes, the through hole is formed by performing nonelectrolytic plating processing etc. In addition, the diameter of the above-mentioned breakthrough for through holes is usually 100-300 micrometers. Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this through hole.

[0078] (2) next, the need — responding — a conductor — perform roughening formation processing on the surface of a circuit. as the above-mentioned roughening formation processing — melanism (oxidization) — the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. can be mentioned. the case where a roughening side is formed here — the average relative roughness of this roughening side — usually — 0.1-5 micrometers — desirable — a conductor — the adhesion of a circuit and a layer insulation layer, and a conductor — when the effect to the electrical signal transmission ability of a circuit etc. is taken into consideration, 2-4 micrometers is more desirable. In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.

[0079] (3) next, a conductor — form the resin layer which forms the resin layer which is not hardened [which some of thermosetting resin photopolymers, and thermosetting resin become from the acrylic-ized resin, these and thermoplastics, and the included resin complex] on the substrate in which the circuit was formed, or consists of thermoplastics. The resin layer which is not hardened [above-mentioned] can be formed by applying non-hardened resin by the roll coater, a curtain coating machine, etc., or carrying out thermocompression bonding of the resin film non-hardened (semi-hardening). Moreover, the resin layer which consists of the above-mentioned thermoplastics can be formed by carrying out thermocompression bonding of the resin Plastic solid fabricated in the shape of a film.

[0080] In these, the approach of carrying out thermocompression bonding of the resin film non-hardened (semi-hardening) is desirable, and sticking by pressure of a resin film can be performed for example, using a vacuum laminator etc. Moreover, although what is necessary is not to limit especially sticking-by-pressure conditions, but just to choose suitably in consideration of the presentation of a resin film etc., it is usually desirable to carry out on a pressure 0.25 - 1.0MPa, the temperature of 40-70 degrees C, the degree of vacuum of 13-1300Pa, and about [time amount 10-120 second] conditions.

[0081] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, polyphenylene resin, a fluororesin, etc. are mentioned, for example. As an example of the above-mentioned epoxy resin, novolak mold epoxy resins, such as a phenol novolak mold and a cresol novolak mold, the cycloaliphatic epoxy resin which carried out dicyclopentadiene conversion are mentioned, for example.

[0082] As the above-mentioned photopolymer, acrylic resin etc. is mentioned, for example. Moreover, the thing to which the heat-curing radical, and the methacrylic acid and acrylic acid of the above-mentioned thermosetting resin were made to acrylic—ization-react as resin which acrylic-ized some above-mentioned thermosetting resin for example, is mentioned.

[0083] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone (PES), polysulfone (PSF), polyphenylene sulfone (PPS) polyphenylene sulfide (PPES), polyphenylene ether (PPE) polyether imide (PI), etc. are mentioned, for example.

[0084] Moreover, as the above-mentioned resin complex, especially if thermosetting resin, a photopolymer (the resin which acrylic-ized some thermosetting resin is also included), and thermoplastics are included, it will not be limited, but as a concrete combination of thermosetting resin and thermoplastics, phenol resin / polyether sulfone, polyimide resin/polysulfone, an epoxy resin / polyether sulfone, an epoxy resin/phenoxy resin, etc. are mentioned, for example. Moreover, as a concrete combination of a photopolymer and thermoplastics, acrylic resin/phenoxy resin, an epoxy resin / polyether sulfone etc. that acrylic-ized a part of epoxy group are mentioned, for example.

[0085] Moreover, as for the rate of a compounding ratio of thermosetting resin and the photopolymer in the above-mentioned resin complex, and thermoplastics, thermosetting resin or a photopolymer / thermoplastics =95 / 5 - 50/50 are desirable. It is because a high toughness value is securable, without spoiling thermal resistance.

[0086] Moreover, the above-mentioned resin layer may consist of resin layers from which it differs more than two-layer. It is that a lower layer is formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =50/50, and the upper layer is specifically formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =90/10 etc. While securing the outstanding adhesion with a substrate by making it such a configuration, the formation ease at the time of forming opening for the Bahia halls etc. at an after process is securable.

[0087] Moreover, the above-mentioned resin layer may be formed using the resin constituent for roughening side formation. The matter of fusibility is distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which serves as the above-mentioned resin constituent for roughening side formation from at least one sort chosen from an acid, alkali, and an oxidizer. In addition, when the same time amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.
[0088] In case the above-mentioned roughening liquid is used for a layer insulation layer and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, by using a photopolymer, exposure and a development may be used for a layer insulation layer, and opening for the Bahia halls may be formed.
[0089] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a fluororesin, etc. are mentioned, for example. Moreover, when sensitization-izing the above-mentioned thermosetting resin, a heat-curing radical is made to acrylic(meta)--ization-react using a methacrylic acid, an acrylic acid, etc.
[0090] As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.
[0091] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.
[0092] It is desirable that it is at least one sort as which the matter of fusibility is chosen from an inorganic particle, a resin particle, and metal particles to the roughening liquid which consists of at least one sort chosen from the above-mentioned acid, alkali, and an oxidizer.
[0093] As the above-mentioned inorganic particle, an aluminium compound, a lime compound, a potassium compound, a magnesium compound, a silicon compound, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.
[0094] As the above-mentioned aluminium compound, as the above-mentioned lime compound, a calcium carbonate, a calcium hydroxide, etc. are mentioned, potassium carbonate etc. is mentioned, an alumina, an aluminum hydroxide, etc. are mentioned and a silica, a zeolite, etc. are mentioned [a magnesia, a dolomite basic magnesium carbonate, talc, etc. are mentioned, and] as the above-mentioned silicon compound as the above-mentioned magnesium compound as the above-mentioned potassium compound, for example. These may be used independently and may be used together two or more sorts.
[0095] Dissolution clearance of the above-mentioned alumina particle can be carried out by fluoric acid, and dissolution clearance of the calcium carbonate can be carried out with a hydrochloric acid. Moreover, dissolution clearance of a sodium content silica or the dolomite can be carried out in an alkali water solution.
[0096] As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. are mentioned. These may be used independently and may be used together two or more sorts. In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle will dissolve in the solvent in which a heat-resistant-resin matrix is dissolved if it is not made to harden.
[0097] Moreover, as the above-mentioned resin particle, a rubber particle, liquid phase resin, liquid phase rubber, etc. may be used. As the above-mentioned rubber particle, acrylonitrile-butadiene rubber, polychloroprene rubber, polyisoprene rubber, acrylic rubber, multi-** system rigidity rubber, a fluororubber, polyurethane rubber, silicone rubber, ABS plastics, etc. are mentioned, for example. Moreover, for example, various denaturation polybutadiene rubbers, such as polybutadiene rubber, epoxy denaturation, urethane denaturation, and acrylonitrile (meta) denaturation, the acrylonitrile-butadiene rubber (meta) containing a carboxyl group, etc. may be used.

[0098] As the above-mentioned liquid phase resin, the non-hardened solution of the above-mentioned thermosetting resin can be used, and epoxy non-hardened oligomer, the mixed liquor of an amine system curing agent, etc. are mentioned as an example of such liquid phase resin, for example. As the above-mentioned liquid phase rubber, non-hardened solutions, such as various denaturation polybutadiene rubbers, such as the above-mentioned polybutadiene rubber, epoxy denaturation, urethane denaturation, and acrylonitrile (meta) denaturation, and acrylonitrile-butadiene rubber (meta) containing a carboxyl group, etc. can be used, for example.

[0099] To prepare the above-mentioned photopolymer constituent using the above-mentioned liquid phase resin or liquid phase rubber, a heat-resistant-resin matrix and the matter of fusibility need to dissolve and twist to homogeneity (that is, phase separation is carried out like), and need to choose these matter like. By mixing the heat-resistant-resin matrix chosen by the above-mentioned criteria and the matter of fusibility, the photopolymer constituent in the condition that the "island" of a heat-resistant-resin matrix is distributing in the "sea" of the condition which the "island" of liquid phase resin or liquid phase rubber is distributing in the "sea" of the above-mentioned heat-resistant-resin matrix, liquid phase resin, or liquid phase rubber can be prepared. And after stiffening the photopolymer constituent of such a condition, a roughening side can be formed by removing the liquid phase resin or liquid phase rubber of the "sea" or a an "island."

[0100] As the above-mentioned metal particles, gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.

[0101] When two or more sorts are mixed and it uses the matter of the above-mentioned fusibility, as a combination of the matter of two sorts of fusibility to mix, the combination of a resin particle and an inorganic particle is desirable. the layer insulation layer which adjustment of thermal expansion tends to plan them between poorly soluble resin, and they become from the resin constituent for roughening side formation while both of conductivity can be hurt low and can secure the insulation of a layer insulation layer -- a crack -- not generating -- a layer insulation layer and a conductor -- it is because exfoliation does not occur between circuits.

[0102] It is desirable to use an organic acid in these as an acid used as the above-mentioned roughening liquid, for example, although organic acids, such as a phosphoric acid, a hydrochloric acid, a sulfuric acid, a nitric acid, and formic acid, an acetic acid, etc. are mentioned. It is because it is hard to make the metallic conductor layer exposed from the Bahia hall corrode when roughening processing is carried out. As the above-mentioned oxidizer, it is desirable to, use the water solution of a chromic acid, chromate acid mixture, and alkaline permanganates (potassium permanganate etc.) etc. for example. Moreover, as the above-mentioned alkali, water solutions, such as a sodium hydroxide and a potassium hydroxide, are desirable.

[0103] The mean particle diameter of the matter of the above-mentioned fusibility has desirable 10 micrometers or less. Moreover, big coarse grain and mean particle diameter may use it combining a small particle relatively relatively [mean particle diameter / the mean particle diameter of 2 micrometers or less]. That is, it is combining the matter of the fusibility whose mean particle diameter's is 0.1-0.5 micrometers, and the matter of the fusibility whose mean particle diameter's is 1-2 micrometers etc.

[0104] Thus, when big coarse grain and mean particle diameter combine a small particle relatively relatively [particle / average], the dissolution residue of a thin film conductor layer can be lost, the amount of palladium catalysts under plating resist can be lessened, and a still shallower and complicated roughening side can be formed. Furthermore, by forming a complicated roughening side, even if the irregularity of a roughening side is small, the practical Peel reinforcement is maintainable. Mean particle diameter exceeds 0.8 micrometers, and that of the above-mentioned coarse grain is less than 2.0 micrometers, and, as for a particle, it is desirable for mean particle diameter to be 0.1-0.8 micrometers.

[0105] (4) Next, in forming the layer insulation layer using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin insulating layer, form opening for the Bahia halls and consider as a layer insulation layer. Moreover, at this process, the breakthrough for through holes may be formed if needed. As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. Moreover, when a photopolymer is used as an ingredient of a layer insulation layer, you may form by the exposure development.

[0106] Moreover, in forming the layer insulation layer using thermoplastics as the ingredient, opening for the Bahia halls is formed in the resin layer which consists of thermoplastics, and it considers as a layer insulation layer. In this case, opening for the Bahia halls can be formed by giving the lasing. Moreover, what is necessary is just to form this breakthrough for through holes by drilling, the lasing, etc., when forming the breakthrough for through holes at this process.

[0107] As laser used for the above-mentioned lasing, carbon dioxide gas laser, ultraviolet laser, excimer laser, etc. are mentioned, for example. In these, excimer laser and the carbon dioxide gas laser of a short pulse are desirable.
[0108] Moreover, it is desirable also in excimer laser to use the excimer laser of a hologram method. A hologram method is a method which irradiates a laser beam through a hologram, a condenser lens, a laser mask, an imprint lens, etc. at the specified substance, and much openings can be once formed in a resin film layer efficiently by exposure by using this method.
[0109] Moreover, when using carbon dioxide gas laser, as for the pulse separation, it is desirable that they are 10-4 - 10 to 8 seconds. Moreover, as for the time amount which irradiates the laser for forming opening, it is desirable that it is 10 - 500 microseconds. Moreover, much openings for the Bahia halls can be formed at once by irradiating a laser beam through an optical-system lens and a mask. By minding an optical-system lens and a mask, it is the same reinforcement and is because exposure reinforcement can irradiate the same laser beam at two or more parts. Thus, after forming opening for the Bahia halls, DESUMIA processing may be performed if needed.
[0110] (5) next, the front face of a layer insulation layer including the wall of opening for the Bahia halls — a conductor — form a circuit. a conductor — in forming a circuit, a thin film conductor layer is first formed in the front face of a layer insulation layer. The above-mentioned thin film conductor layer can be formed by approaches, such as nonelectrolytic plating and sputtering.
[0111] As construction material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example. In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, profitability, etc. is desirable. Moreover, as thickness of the above-mentioned thin film conductor layer, when forming a thin film conductor layer with nonelectrolytic plating, 0.3-2.0 micrometers is desirable and 0.6-1.2 micrometers is more desirable. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable.
[0112] Moreover, a roughening side may be formed in the front face of a layer insulation layer before forming the above-mentioned thin film conductor layer. By forming a roughening side, the adhesion of a layer insulation layer and a thin film conductor layer can be raised. When a layer insulation layer is especially formed using the resin constituent for roughening side formation, it is desirable to form a roughening side using an acid, an oxidizer, etc.

[0113] Moreover, when the breakthrough for through holes is formed at the process of the above (4), in case a thin film conductor layer is formed on a layer insulation layer, it is good also as a through hole by forming a thin film conductor layer also in the wall surface of a breakthrough.
[0114] (6) Subsequently, form plating resist on the substrate with which the thin film conductor layer was formed in the front face. After the above-mentioned plating resist sticks for example, a photosensitive dry film, it can carry out adhesion arrangement of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and can form it by performing an exposure development.
[0115] (7) After that, electroplate by making a thin film conductor layer into a plating bar, and form a electroplating layer in the above-mentioned plating-resist agenesis section. As the above-mentioned electroplating, copper plating is desirable. Moreover, the thickness of the above-mentioned electroplating layer and 5-20 micrometers are desirable.
[0116] then, the thing for which the thin film conductor layer under the above-mentioned plating resist and this plating resist is removed — a conductor — a circuit (the Bahia hall is included) can be formed. What is necessary is just to perform clearance of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform clearance of the above-mentioned plating resist for example, using an alkali water solution etc. moreover, the above — a conductor — after forming a circuit, the catalyst on a layer insulation layer may be removed using an acid or an oxidizer if needed. It is because lowering of an electrical property can be prevented. moreover, the method of performing etching processing, after replacing with the approach (a process (6) and (7)) of forming a electroplating layer after forming this plating resist and forming a electroplating layer the whole surface on a thin film conductor layer — using — a conductor — a circuit may be formed.
[0117] Moreover, when a through hole is formed in the above (4) and the process of (5), it may be filled up with a resin filler in this through hole. Moreover, when filled up with a resin filler in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating if needed.
[0118] (8) Next, when a lid plating layer is formed, if needed, perform roughening processing on the front face of this lid plating layer, and form a layer insulation layer by repeating the above (3) and the process of (4) further. In addition, a through hole may be formed and it is not necessary to form at this process.

(9) — repeating the process of (5) - (8) further if needed — a conductor — laminating formation of a circuit and the layer insulation layer may be carried out.

[0119] performing the process of such (1) - (9) — both sides of a substrate — a conductor — the multilayer-interconnection plate with which laminating formation of a circuit and the layer insulation layer was carried out can be manufactured. in addition, the manufacture approach of the multilayer-interconnection plate explained in full detail here — semi ADITEBU — the manufacture approach of the multilayer-interconnection plate manufactured at the process of the above (a) although it is law — semi ADITEBU — it limits to law — not having — full ADITEBU — it can also carry out using law, a subtractive process, a package laminated layers method, the conformal method, etc.

[0120] By the manufacture approach of the substrate for IC chip mounting of the second this invention, after manufacturing a multilayer-interconnection plate through the process of the above (a), the process of the above (b), i.e., the through-hole formation process which forms a breakthrough in the above-mentioned multilayer-interconnection plate, is performed. The breakthrough formed at this process will play the role of the optical path for lightwave signal transmission in the substrate for IC chip mounting. Therefore, the breakthrough formed at this process is hereafter called breakthrough for optical paths.

[0121] Drilling, the lasing, etc. perform formation of the above-mentioned breakthrough for optical paths. The same thing as the laser used in formation of the above-mentioned opening for the Bahia halls as laser used in the above-mentioned lasing etc. is mentioned. especially the formation location of the above-mentioned breakthrough for optical paths is limited — not having — a conductor — what is necessary is just to choose suitably in consideration of the mounting position of the design of a circuit, and IC chip etc. Moreover, as for the above-mentioned breakthrough for optical paths, it is desirable to form for every optical elements, such as a photo detector and a light emitting device. Moreover, you may form for every signal wave length.

[0122] Moreover, DESUMIA processing may be performed after the breakthrough formation for optical paths if needed. The above-mentioned DESUMIA processing can be performed using processing for example, by the permanganic acid solution, plasma treatment, corona treatment, etc. In addition, by performing the above-mentioned DESUMIA processing, the resin remainder in the breakthrough for optical paths, weld flash, etc. can be removed, and the transmission loss resulting from the scattered reflection in the wall surface of the optical path for lightwave signal transmission can be reduced.

[0123] Moreover, after the breakthrough formation for optical paths, before forming a conductor layer or filling up a non-hardened resin constituent with the following process, the roughening side formation process which makes a roughening side the wall surface of the breakthrough for optical paths may be performed if needed. It is because improvement in adhesion with a conductor layer or a resin constituent can be aimed at. Formation of the above-mentioned roughening side can be performed by dissolving the part exposed with oxidizers, such as acid; chromic acids, such as a sulfuric acid, a hydrochloric acid, and a nitric acid, chromate acid mixture, and a permanganate, etc. when breakthroughs for optical paths, such as a substrate and a layer insulation layer, were formed. Moreover, plasma treatment, corona treatment, etc. can also perform. The average relative roughness (Ra) of the above-mentioned roughening side has desirable 0.5-5 micrometers, and its 1-3 micrometers are more desirable. if it is this range, it excels in adhesion with a conductor layer or a resin constituent — it is both because it does not have an adverse effect on transmission of a lightwave signal.

[0124] After forming the above-mentioned breakthrough for optical paths, the conductor-layer formation process which forms a conductor layer in the wall surface of the above-mentioned breakthrough for optical paths may be performed if needed. Formation of the above-mentioned conductor layer can be performed by approaches, such as nonelectrolytic plating and sputtering. After forming the breakthrough for optical paths, a catalyst nucleus can be given to the wall surface of this breakthrough for optical paths, and, specifically, the approach immersed in a nonelectrolytic plating bath in the substrate with which the breakthrough for optical paths was formed can be used after that. Moreover, the conductor layer which consists of more than two-layer combining nonelectrolytic plating or sputtering may be formed, and the conductor layer which performs electrolysis plating and consists of more than two-layer may be formed after nonelectrolytic plating or sputtering.

[0125] the layer insulation layer top formed at the process of the above (a) in such a conductor-layer formation process while forming the conductor layer in the wall surface of the above-mentioned breakthrough for optical paths — the conductor of an outermost layer of drum — it is desirable to form a circuit. First, in case a conductor layer is formed in the wall surface of the breakthrough for optical paths with nonelectrolytic plating etc., specifically, a conductor layer is formed also in the whole front face of a layer insulation layer.

[0126] Next, plating resist is formed on the conductor layer formed in this layer insulation layer front face. After formation of plating resist sticks for example, a photosensitive dry film, it carries out adhesion installation of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and forms it by

performing an exposure development.
[0127] furthermore, the conductor which became independent on the layer insulation layer by performing electrolysis plating by making into a plating bar the conductor layer formed on the above-mentioned layer insulation layer, forming a electroplating layer in the above-mentioned plating-resist agenesis section, and removing the conductor layer under the above-mentioned plating resist and this plating resist after that -- a circuit is formed.
[0128] Moreover, a roughening layer may be formed in the wall surface of the above-mentioned conductor layer after forming the above-mentioned conductor layer. formation of the above-mentioned roughening layer -- for example, melanism (oxidization) -- it can carry out using the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. Moreover, it may replace with a roughening layer or an enveloping layer may be formed with a roughening layer.
[0129] Moreover, after forming the above-mentioned breakthrough for optical paths, the resin restoration process which fills up this breakthrough with a non-hardened resin constituent may be performed if needed. After being filled up with a non-hardened resin constituent, at least the part can form the optical path for lightwave signal transmission constituted with a resin constituent by performing hardening processing. It is not limited especially as the restoration approach of the resin constituent which is not hardened [concrete], for example, approaches, such as printing and potting, can be used. In addition, when filled up with a non-hardened resin constituent by printing, a non-hardened resin constituent may be printed at once and may be printed in 2 steps or more. Moreover, printing may be performed from both sides of a multilayer-interconnection plate.
[0130] Moreover, in case it is filled up with a non-hardened resin constituent, it may be filled up with the resin constituent which is not hardened [of somewhat many amounts], and the excessive resin constituent with which it overflowed from the breakthrough for optical paths may be removed from the inner product of the above-mentioned breakthrough for optical paths after restoration termination. the above -- polish etc. can perform clearance of an excessive resin constituent. Moreover, what is necessary is for the condition of a resin constituent to be in a semi-hardening condition, to be in the condition hardened thoroughly, and just to choose it suitably in consideration of the ingredient of a resin constituent etc., when removing an excessive resin constituent.
[0131] The optical path for lightwave signal transmission can be formed in the multilayer-interconnection plate manufactured through the process of the above (a) by passing through such a through-hole formation process, the roughening side formation process performed if needed, a conductor-layer formation process, and a resin constituent restoration process. moreover, the conductor which became independent by forming a conductor layer also in the front face of a layer insulation layer, and performing processing mentioned above in case the above-mentioned conductor-layer formation process is performed -- a circuit can be formed. of course, the approach which mentioned the above-mentioned conductor layer above even if it was the case where a formation process was not performed -- the front face of a layer insulation layer -- a conductor -- a circuit can be formed.
[0132] Next, the solder resist layer formation process which forms the solder resist layer which has opening which was open for free passage to the breakthrough for optical paths formed at the process of the above (c), i.e., the process of the above (b), is performed. Specifically, a solder resist layer can be formed by performing following (1) and the process of (2).
[0133] (1) Form the layer of a solder resist constituent in the outermost layer of drum of the multilayer-interconnection plate in which the breakthrough for optical paths was formed, first. The layer of the above-mentioned solder resist constituent can be formed using the solder resist constituent which consists of for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.
[0134] moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 - 10 Pa-s at 25 degrees C. Moreover, the film which consists of the above-mentioned solder resist constituent is stuck by pressure, and the layer of a solder resist constituent may be formed. Especially when the breakthrough for optical paths is constituted by the opening, it is desirable to stick a film by pressure and to form the layer of a solder resist constituent.
[0135] (2) Next, form opening (henceforth opening for optical paths) which was open for free passage in the layer of the above-mentioned solder resist constituent at the above-mentioned breakthrough for optical paths.

Specifically, it can form by the exposure development, the lasing, etc. Moreover, in case the above-mentioned opening for optical paths is formed, it is desirable simultaneously to form opening for solder bump formation. In addition, formation and formation of the above-mentioned opening for solder bump formation are [opening / above-mentioned / for optical paths] independently good in a line. Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for optical paths and opening for solder bump formation may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.

[0136] Moreover, at this process, after forming opening for optical paths, this opening for optical paths can be filled up with a non-hardened resin constituent, and the optical path for lightwave signal transmission constituted by the conductor layer of a resin constituent or a resin constituent, and its perimeter can be formed by performing hardening processing after that. In addition, as for the resin constituent which is not hardened [with which it is filled up here], what consists of the same presentation as un-hardening and the resin constituent filled with the process of the above (b) is desirable.

[0137] Moreover, it is not limited especially as an approach filled up with the resin constituent which is not hardened [above-mentioned], but the approach used when filling up a non-hardened resin constituent with the process of the above (b) into the breakthrough for optical paths, the same approach, etc. can be used. When filling up a non-hardened resin constituent with this process, at the process of the above (b) in addition, previously Although it is desirable to be filled up with a non-hardened resin constituent in the breakthrough for optical paths, it sets at the process of the above (b). Restoration of a non-hardened resin constituent is not performed, but it is this process, and after forming opening for optical paths, this opening for optical paths and the above-mentioned breakthrough for optical paths may be simultaneously filled up with a non-hardened resin constituent.

[0138] By passing through such a process of (1) and (2), the solder resist layer which has this breakthrough for optical paths and opening which was open for free passage can be formed on the multilayer-interconnection plate with which the breakthrough for optical paths was formed.

[0139] Moreover, after forming the above-mentioned breakthrough for optical paths, and the above-mentioned opening for optical paths, the micro-lens arrangement process which arranges a micro lens in the edge of this opening for optical paths may be performed if needed. As for arrangement of the above-mentioned micro lens, it is desirable to carry out by attaching an optical lens through an adhesives layer.

[0140] Moreover, when arranging a micro lens using the resin for optical lenses, optimum dose dropping of the non-hardened resin for optical lenses can be carried out, and a micro lens can be arranged in the edge of the above-mentioned opening for optical optical paths by performing hardening processing to the resin for optical lenses which is not hardened [this]. Therefore, it is desirable to fill up with the resin constituent in the above-mentioned opening for optical paths in this case. When using such an approach, dropping of the non-hardened resin for optical lenses can be performed using equipments, such as a dispenser, an ink jet, a micropipette, and a micro syringe. Moreover, since the resin for optical lenses which is not hardened [which was dropped using these equipments] tends to become a globular form with surface tension, it becomes hemispherical at the edge (edge of a resin constituent) of opening for optical paths, and the resin for optical lenses of the shape of this semi-sphere serves as a micro lens after hardening. Moreover, a diameter of a micro lens, a configuration of a curved surface, etc. which consist of resin for optical lenses are controllable by the thing of a resin constituent and the non-hardened resin for optical lenses for which the viscosity of the non-hardened resin for optical lenses etc. is adjusted suitably, being smeared and taking a sex etc. into consideration.

[0141] In addition, when arranging a micro lens in the optical path for lightwave signal transmission which consists of a resin constituent and an opening or a resin constituent and an opening, and a conductor layer of these perimeters, a micro lens may be arranged in the edge of a resin constituent, and the arrangement location of a micro lens is not limited to the edge of the optical path for lightwave signal transmission in this case.

[0142] Moreover, although the breakthrough for optical paths is formed in this multilayer-interconnection plate and formation of a solder resist layer is performed after that by the manufacture approach of the second this invention of performing the process of above-mentioned (a) - (c) after manufacturing a multilayer-interconnection plate In case the substrate for IC chip mounting of the first this invention is manufactured, after manufacturing a multilayer-interconnection plate depending on the case, the breakthrough for forming a solder resist layer and forming the optical path for lightwave signal transmission after that previously, may be formed.

[0143] By the manufacture approach of the substrate for IC chip mounting of the second this invention, after performing the process of such (a) - (c), the substrate for IC chip mounting can be manufactured by performing formation of a solder pad or a solder bump, and mounting of an optical element using the following approach.

[0144] namely, the conductor exposed by forming the above-mentioned opening for solder bump formation — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and

platinum, and let it be a solder pad. In these, it is desirable to form an enveloping layer with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold. Although the above-mentioned enveloping layer can be formed according to plating, vacuum evaporationo, electrodeposition, etc., in these, it is desirable to form with plating from the point of excelling in the homogeneity of an enveloping layer.

[0145] Furthermore, after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad, a solder bump is formed by carrying out a reflow.

[0146] Furthermore, an optical element (a photo detector and light emitting device) is mounted in a solder resist layer. Mounting of an optical element can be performed for example, through the above-mentioned solder bump. Moreover, for example, in case the above-mentioned solder bump is formed, when filled up with soldering paste, the optical element is attached, and an optical element may be mounted in a reflow and coincidence. Moreover, it may replace with solder and an optical element may be mounted using electroconductive glue etc. By passing through such a process, the substrate for IC chip mounting of the first this invention can be manufactured.

[0147] Next, the device for optical communication of the third this invention is explained. The device for optical communication of the third this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board, and is characterized by forming in the above-mentioned substrate for IC chip mounting the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting.

[0148] In the device for optical communication of the third this invention, a lightwave signal can be transmitted through the optical path for lightwave signal transmission formed in the above-mentioned substrate for IC chip mounting.

[0149] Although it will not be limited especially if the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is formed as a substrate for IC chip mounting which constitutes the above-mentioned device for optical communication, the substrate for IC chip mounting of the first this invention mentioned above is desirable. As a substrate for IC chip mounting, it is because the various effectiveness mentioned above can be acquired by using the substrate for IC chip mounting of the first this invention.

[0150] In addition, a RCC type substrate etc. may be used as a substrate for IC chip mounting with which the optical path for lightwave signal transmission of the above-mentioned configuration is formed.

[0151] Moreover, although the solder resist layer is formed in the outermost layer of drum in the substrate for IC chip mounting of the first this invention, the solder resist layer does not need to be formed in the outermost layer of drum in the substrate for IC chip mounting which constitutes the device for optical communication of the third this invention. However, when the solder resist layer is formed in the outermost layer of drum of the substrate for IC chip mounting, when connecting with a multilayer printed wiring board through a solder bump etc., or in case the surface mount of the optical element is carried out, the effectiveness of the alignment by self-alignment operation can be acquired.

[0152] as the multilayer printed wiring board which constitutes the above-mentioned device for optical communication — a substrate and a conductor — it is constituted including a circuit and that in which optical waveguide was formed is mentioned further. In such a multilayer printed wiring board, a lightwave signal can be transmitted through optical waveguide. Moreover, in the above-mentioned multilayer printed wiring board, between the above-mentioned substrates for IC chip mounting (for example, between the optical elements mounted in the above-mentioned substrate for IC chip mounting), the optical path for lightwave signal transmission may be formed if needed so that a lightwave signal can be transmitted.

[0153] As an ingredient of the above-mentioned optical waveguide, quartz glass, a compound semiconductor, a polymer ingredient, etc. are mentioned, for example. In these, while excelling in workability, it excels in adhesion with the layer insulation layer of a multilayer printed wiring board, and the point which is low cost to a polymer is desirable.

[0154] As the above-mentioned polymer ingredient, a well-known thing can be used conventionally, and, specifically, the polymer manufactured from silicone resin; benz-cyclo-butene, such as polyimide resin; epoxy resin;UV hardenability epoxy resin; deuteration silicone resin, such as acrylic resin; fluorination polyimide, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, is mentioned.

[0155] Moreover, the thickness of the above-mentioned optical waveguide has desirable 1-50 micrometers, and the width of face has desirable 1-50 micrometers. Moreover, the photo detector and the light emitting device are mounted in the above-mentioned substrate for IC chip mounting, and in the above-mentioned multilayer printed wiring board, when optical waveguide is formed in each location which counters the above-mentioned photo detector and a light emitting device, it is desirable for the optical waveguide formed in the location which counters the above-mentioned photo detector, and the optical waveguide formed in the location which counters

the above-mentioned light emitting device to be what consists of the same ingredient.

[0156] Moreover, it is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide. By forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle. Formation of the above-mentioned optical-path conversion mirror can be performed by carrying out grinding of the end of optical waveguide so that it may mention later.

[0157] Moreover, as for the above-mentioned multilayer printed wiring board, it is desirable to form the solder bump for transmitting an electrical signal. Thereby, it is because an electrical signal can be transmitted between external electronic parts or an external substrate. Moreover, when the solder bump is formed, both can be stationed to the position which the photo detector and light emitting device which were mounted in the substrate for IC chip mounting, and the optical waveguide formed in the multilayer printed wiring board counter by connecting the substrate for IC chip mounting, and a multilayer printed wiring board through a solder bump. It is because a self-alignment operation of solder can be used. In addition, the same effectiveness can be acquired also when the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board are connected through PGA or BGA.

[0158] As explained above, the device for optical communication of the third this invention The substrate for IC chip mounting with which an optical path for lightwave signal transmission which was mentioned above was formed, The substrate for IC chip mounting with which the photo detector and the light emitting device were mounted although it was not limited especially when consisting of a multilayer printed wiring board, It is desirable to be constituted so that it consists of a multilayer printed wiring board with which optical waveguide was formed and a lightwave signal can be transmitted through the optical path for lightwave signal transmission between the above-mentioned photo detector and a light emitting device, and optical waveguide.

[0159] The operation gestalt of the device for optical communication of the third this invention is explained referring to a drawing. Drawing 3 is the sectional view showing typically 1 operation gestalt of the device for optical communication of the third this invention. In addition, drawing 3 shows the device for optical communication in the condition that IC chip was mounted.

[0160] As shown in drawing 3 , the device 250 for optical communication of the third this invention consists of the substrates 220 for IC chip mounting and multilayer printed wiring boards 200 which mounted the IC chip 240, and the substrate 220 for IC chip mounting and the multilayer printed wiring board 200 are electrically connected through the solder connection 241.

[0161] the substrate 220 for IC chip mounting — both sides of a substrate 221 — a conductor — the conductor with which laminating formation was carried out and the substrate 221 of the layer insulation layer [a circuit 224 and] 222 was pinched — circuits and the conductor whose layer insulation layer 222 was pinched — circuits are electrically connected by the through hole 229 and the Bahia hall 227, respectively. Moreover, the optical path 251 for lightwave signal transmission which penetrates this is formed in the substrate 220 for IC chip mounting, conductor-layer 251b is formed in a part of that wall surface, and, as for this optical path 251 for lightwave signal transmission, a part of that interior is further filled up with resin constituent 251a. Therefore, the optical path 251 for lightwave signal transmission consists of a resin constituent and an opening, and a conductor layer of these perimeters.

[0162] Moreover, a photo detector 238 and a light emitting device 239 are mounted in the near field where the IC chip 240 was mounted, and through the optical path 251 for lightwave signal transmission, it consists of substrates 220 for IC chip mounting so that a lightwave signal can be transmitted between a photo detector 238, a light emitting device 239, and optical waveguide 219 (219a, 219b). Furthermore, the solder resist layer 234 equipped with the solder bump is formed in the outermost layer of drum of the mounting substrate 220 for IC chip.

[0163] a multilayer printed wiring board 200 — both sides of a substrate 201 — a conductor — the conductor with which laminating formation was carried out and the substrate 201 of the layer insulation layer [a circuit 204 and] 202 was pinched — circuits and the conductor whose layer insulation layer 202 was pinched — circuits are electrically connected by the through hole 209 and the Bahia hall 207, respectively. Moreover, while the solder resist layer 214 equipped with the opening 211 for optical paths and a solder bump is formed in the mounting substrate 220 for IC chip of a multilayer printed wiring board 200, and the outermost layer of drum of the side which counters, the optical waveguide 218 (218a, 218b) equipped with the optical conversion mirror 219 (219a, 219b) is formed directly under [for optical paths] opening 211 (211a, 211b).

[0164] In the device 250 for optical communication which consists of such a configuration The lightwave signal sent from the outside through an optical fiber (not shown) is introduced into optical waveguide 218a. After being sent to the photo detector 238 (light sensing portion 238a) through optical-path conversion mirror 219a, opening 211for optical paths a, and the optical path 251 for lightwave signal transmission, it changes into an electrical signal by the photo detector 238 — having — further — the solder connection 242 and a conductor — it will be

sent to the IC chip 240 through a circuit 224, the Bahia hall 227, and the solder connection 243.
[0165] Moreover, the electrical signal sent out from the IC chip 240 the solder connection 243, the Bahia hall 227, and a conductor — a circuit 224 — and After being sent to a light emitting device 239 through the solder connection 242, it is changed into a lightwave signal by the light emitting device 239. this lightwave signal — the optical path 251 for lightwave signal transmission from a light emitting device 239 (light-emitting part 239a), and opening 211for optical paths b — and it conversion mirror [optical] 219b minds, is introduced into optical waveguide 218b, and is delivery outside as a lightwave signal through an optical fiber (not shown) further — it will be carried out.
[0166] In the device for optical communication of the third this invention, since light / electrical signal conversion is performed, the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the front face, i.e., IC chip, of the substrate for IC chip mounting. moreover, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder connection — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included). Moreover, with the device 250 for optical communication which consists of such a configuration, since it is hard to generate location gap in the photo detector mounted in the substrate for IC chip mounting, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board, it will excel in the connection dependability of a lightwave signal.
[0167] In addition, although the formation location of the optical waveguide in the multilayer printed wiring board shown in drawing 3 is on the layer insulation layer of the outermost layer of drum of the side near the substrate for IC chip mounting, in the multilayer printed wiring board which constitutes the substrate for IC chip mounting of the third this invention, the formation location of optical waveguide may not necessarily be limited here, may be between layer insulation layers, and may be on a substrate.
[0168] Next, how to manufacture the device for optical communication of the third this invention is explained. First, manufacture of the above-mentioned device for optical communication can manufacture independently the substrate for IC chip mounting, and a multilayer printed wiring board, and can be performed by connecting both through solder etc. after that, for example. Therefore, how to manufacture each of the substrate for IC chip mounting and a multilayer printed wiring board is explained first, and how to connect both is explained after that here.
[0169] As an approach of manufacturing the above-mentioned substrate for IC chip mounting, the approach of manufacturing the substrate for IC chip mounting of the first this invention, the same approach, etc. can be used, for example. In addition, as the substrate for IC chip mounting which constitutes the device for optical communication of the third this invention was mentioned above, the solder resist layer does not necessarily need to be formed. Therefore, in the manufacture approach of the substrate for IC chip mounting of the second this invention, when manufacturing the substrate for IC chip mounting with which the solder resist layer is not formed, if the process of (c) is not performed, it is good.
[0170] As an approach of manufacturing the above-mentioned multilayer printed wiring board, the approach of performing the process of following the (1) - (6) etc. can be used, for example.
(1) Manufacture a multilayer-interconnection plate using the same approach as the process of (a) of the manufacture approach of the substrate for IC chip mounting of the second this invention.
[0171] (2) next, the conductor on the layer insulation layer of the above-mentioned multilayer-interconnection plate — form optical waveguide in the circuit agenesis section. Formation of the above-mentioned optical waveguide can be performed by attaching beforehand the optical waveguide fabricated in the predetermined configuration through adhesives, when carrying out by using inorganic materials, such as quartz glass, for the ingredient. The optical waveguide which consists of the above-mentioned inorganic material can be formed by making the inorganic material of $LiNbO_3$ and $LiTaO_3$ grade form by the liquid-phase-epitaxial method, the chemistry depositing method (CVD), a molecular beam epitaxy, etc.
[0172] Moreover, when forming the above-mentioned optical waveguide using a polymer ingredient, optical waveguide can be formed by sticking beforehand the film for optical waveguide formation formed in the shape of a film on the substrate or the mold releasing film on a layer insulation layer, or forming in a layer insulation layer directly. Specifically, it can form using a selective polymerization method, the approach using reactive ion etching and photolithography, the direct exposing method, the approach using injection molding, the photograph breeching method, the approach that combined these. In addition, these approaches can be used also when forming directly it forms on a layer insulation layer also when forming optical waveguide on a substrate or a mold releasing film.
[0173] Moreover, an optical-path conversion mirror is formed in the above-mentioned optical waveguide.

Although it may be formed before the above-mentioned optical-path conversion mirror attaches optical waveguide on a layer insulation layer, and it may be formed after attaching it on a layer insulation layer, it is desirable to form an optical-path conversion mirror beforehand except for the case where this optical waveguide is directly formed on a layer insulation layer. other members which can work easily and constitute a multilayer printed wiring board, for example, a conductor, -- it is because a circuit, a layer insulation layer, etc. are damaged or there is no possibility of damaging these.

[0174] It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose head is 90 degrees of V types, processing by reactive ion etching, laser ablation, etc. can be used.

[0175] (3) Next, form a solder resist layer in the outermost layer of drum of the multilayer-interconnection plate in which optical waveguide was formed. The above-mentioned solder resist layer can be formed using the resin constituent used in case the solder resist layer of for example, the above-mentioned substrate for IC chip mounting is formed, and the same resin constituent. In addition, what is necessary is just to perform formation of the above-mentioned solder resist layer if needed.

[0176] (4) Next, form opening for solder bump formation, and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters. Formation with the above-mentioned opening for solder bump formation and opening for optical paths can be performed to the substrate for IC chip mounting using the approach of forming opening for solder bump formation, and the same approach, i.e., an exposure development, the lasing, etc. In addition, formation of the above-mentioned opening for solder bump formation and formation of opening for optical paths may be performed simultaneously, and are independently good in a line.

[0177] In these, in case a solder resist layer is formed, it is desirable to choose the approach of forming opening for solder bump formation and opening for optical paths by applying the resin constituent which contains a photopolymer as the ingredient, and performing an exposure development. It is because there is no possibility of attaching a blemish to the optical waveguide which exists under this opening for optical paths, at the time of opening formation in forming opening for optical paths by the exposure development. Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for solder bump formation and opening for optical paths may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand.

[0178] Moreover, opening for solder bump formation may be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand if needed. By passing through an after process, it is because an external connection terminal can be formed also in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand.

[0179] Moreover, a resin constituent may be filled up with this process into this opening for optical paths after forming opening for optical paths. In addition, as a resin constituent with which it is filled up in the above-mentioned opening for optical paths, the same thing as the resin constituent with which the breakthrough for optical paths is filled up etc. is mentioned in the manufacture approach of the substrate for IC chip mounting of the second this invention.

[0180] (5) next, the conductor exposed by forming the above-mentioned opening for solder bump formation -- if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, tin, palladium, gold, silver, and platinum, and let it be a solder pad. What is necessary is just to specifically carry out to the substrate for IC chip mounting using the approach of forming a solder pad, and the same approach.

[0181] (6) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned solder pad with soldering paste through the mask with which opening was formed in the part equivalent to the above-mentioned solder pad. In addition, PGA and BGA may be formed depending on the case. Moreover, it is good also as PGA (Pin Grid Array) or BGA (Ball Grid Array) by arranging a pin in an external substrate connection side, or forming a solder ball in the solder resist layer of the substrate for IC chip mounting, the field which counters, and an opposite hand. By passing through such a process, the multilayer printed wiring board which constitutes the device for optical communication of the third this invention can be manufactured.

[0182] Next, how to manufacture the device for optical communication is explained using the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by the above-mentioned approach. First, a solder connection is formed by the solder bump of the above-mentioned substrate for IC chip mounting, and the solder bump of the above-mentioned multilayer printed wiring board, and both are connected electrically. That is, by carrying out opposite arrangement and carrying out a reflow of the substrate for IC chip mounting, and the multilayer printed wiring board after that with the predetermined sense, at a position, respectively, both can be connected and it can consider as the device for optical communication.

[0183] Moreover, in this process, even if some location gap exists among both when opposite arrangement of both is carried out in order to connect the substrate for IC chip mounting, and a multilayer printed wiring board using both solder bump, both can be stationed to a position by the self-alignment effectiveness by solder at the time of a reflow. In addition, the solder bump may be formed only in one of fields among each field of the above-mentioned substrate for IC chip mounting, and a multilayer printed wiring board which counters. It is because both are electrically connectable also in this case.
[0184] Next, IC chip is mounted in the above-mentioned substrate for IC chip mounting, and a resin seal is performed after that if needed. Mounting of the above-mentioned IC chip can be conventionally performed by the well-known approach. In addition, as mentioned above, as for IC chip, what can be mounted by flip chip bonding is desirable. Moreover, mounting of IC chip may be performed before connecting the substrate for IC chip mounting, and a multilayer printed wiring board, and the substrate for IC chip mounting and multilayer printed wiring board which mounted IC chip may be connected. By passing through such a process, the device for optical communication of the third this invention can be manufactured.
[0185] Next, the substrate for IC chip mounting of the fourth this invention is explained. the device for optical communication with which the substrate for IC chip mounting of the fourth this invention consists of a substrate for IC chip mounting, and a multilayer printed wiring board -- it is -- the above-mentioned multilayer printed wiring board -- a substrate and a conductor -- it is constituted including the circuit and considers as the forming [in said multilayer printed wiring board / the optical path for lightwave signal transmission which penetrates a substrate at least] description.
[0186] In the device for optical communication of the fourth this invention, a lightwave signal can be transmitted through the optical path for lightwave signal transmission formed in the above-mentioned multilayer printed wiring board.
[0187] It is not limited especially as a substrate for IC chip mounting which constitutes the above-mentioned device for optical communication, for example, the substrate for IC chip mounting of the first this invention etc. is mentioned. Moreover, the optical path for lightwave signal transmission does not necessarily need to be formed in the substrate for IC chip mounting which constitutes the device for optical communication of the fourth this invention. Therefore, what is necessary is just to attach in the multilayer printed wiring board of the substrate for IC chip mounting, and the side which counters through solder, electroconductive glue, etc., in mounting optical elements, such as a photo detector and a light emitting device, in the above-mentioned substrate for IC chip mounting. In this case, even if the optical path for lightwave signal transmission is not formed in the substrate for IC chip mounting, a lightwave signal can be transmitted between a photo detector, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board. Moreover, also when the optical element is mounted in the multilayer printed wiring board of the substrate for IC chip mounting, and the side which counters, as for this optical element, it is desirable to be mounted in the front face of the substrate for IC chip mounting.
[0188] moreover, the substrate for IC chip mounting which constitutes the device for optical communication of the fourth this invention -- a conductor -- the conductor the circuit, the layer insulation layer, and whose above-mentioned layer insulation layer were pinched -- it is desirable to be constituted including the Bahia hall which connects between circuits. It is because the densification of the substrate for IC chip mounting can be achieved. In addition, a RCC type substrate etc. may be used as the above-mentioned substrate for IC chip mounting.
[0189] Moreover, the solder resist layer does not need to be formed in the outermost layer of drum in the above-mentioned substrate for IC chip mounting. However, when the solder resist layer is formed in the outermost layer of drum of the substrate for IC chip mounting, when connecting with a multilayer printed wiring board through a solder bump etc., or in case the surface mount of the optical element is carried out, the effectiveness of the alignment by self-alignment operation can be acquired.
[0190] moreover, the multilayer printed wiring board which constitutes the device for optical communication of the fourth this invention -- a substrate and a conductor -- it is constituted including the circuit and the optical path for lightwave signal transmission which penetrates the above-mentioned substrate further at least is formed. In such a multilayer printed wiring board, a lightwave signal can be delivered and received between external substrates (substrate for IC chip mounting) through the above-mentioned optical path for lightwave signal transmission.
[0191] Moreover, in the multilayer printed wiring board in which an optical path for lightwave signal transmission which was mentioned above is formed, when forming optical waveguide, the degree of freedom of the formation location of this optical waveguide will increase, and the densification of a multilayer printed wiring board can be achieved. This is because a free space becomes large in the design of a multilayer printed wiring board, when the degree of freedom of the formation location of optical waveguide increases.

[0192] Moreover, in the above-mentioned multilayer printed wiring board, since optical processing and a mechanical process can perform alignment of this optical waveguide on the basis of the optical path for lightwave signal transmission when forming optical waveguide, optical waveguide can be correctly formed in a desired location.
[0193] As for the above-mentioned optical path for lightwave signal transmission, to be constituted by the opening is desirable. When the optical path for lightwave signal transmission is formed of the opening, while the formation is easy, in transmission of the lightwave signal through this optical path for lightwave signal transmission, it is hard to generate transmission loss. In addition, in consideration of the thickness of a substrate etc., it should just determine suitably whether the configuration of the above-mentioned optical path for lightwave signal transmission is made into an opening.
[0194] Moreover, as for the above-mentioned optical path for lightwave signal transmission, to be constituted by the resin constituent and the opening is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent and the opening, lowering of the reinforcement of a multilayer printed wiring board can be prevented.
[0195] Moreover, as for the above-mentioned optical path for lightwave signal transmission, being constituted with the resin constituent is also desirable. When the above-mentioned optical path for lightwave signal transmission is constituted by the resin constituent, lowering of the reinforcement of the substrate for IC chip mounting can be prevented. Moreover, if the optical path for lightwave signal transmission is constituted by the resin constituent, since it can prevent that dust, a foreign matter, etc. enter in this optical path for lightwave signal transmission, it can prevent that originate in existence of dust, a foreign matter, etc. and transmission of a lightwave signal is checked.
[0196] Moreover, in the optical path for lightwave signal transmission which consists of the optical path for lightwave signal transmission, i.e., the opening, and resin constituents of a configuration as mentioned above, it is hard to generate the adverse effect (for example, for the path of the cross section of the optical path for lightwave signal transmission to become small) by heat etc. in the bottom of a heat treatment process or a reliability trial.
[0197] the case where a part or all of the above-mentioned optical path for lightwave signal transmission consists of resin constituents — as this resin constituent — the substrate for IC chip mounting of the first this invention — it is and the same thing as the resin constituent which constitutes the optical path for lightwave signal transmission etc. is mentioned.
[0198] Especially the configuration of the above-mentioned optical path for lightwave signal transmission is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned. In these, the shape of a cylinder is desirable. It is because the formation is easy.
[0199] Moreover, a minimum with the desirable path of the cross section of the above-mentioned optical path for lightwave signal transmission is 100 micrometers, and a desirable upper limit is 500 micrometers. While there is a possibility that an optical path may be closed for the path of the above-mentioned cross section by less than 100 micrometers, when this a part of optical path [at least] for lightwave signal transmission consists of resin constituents, it is difficult to be filled up with a non-hardened resin constituent. the conductor which whose transmission nature of a lightwave signal seldom improves on the other hand even if it makes the path of the above-mentioned cross section larger than 500 micrometers, but constitutes a multilayer printed wiring board — it is because it may become the cause which checks the degree of freedom of designs, such as a circuit. A minimum is 250 micrometers and the upper limit of the path of a more desirable cross section is 350 micrometers. It is because inconvenience does not occur also in case both the transmission nature of a lightwave signal and the degree of freedom of a design are excellent and it is filled up with a non-hardened resin constituent.
[0200] As for the above-mentioned optical path for lightwave signal transmission, it is desirable to consist of an opening and a conductor layer of the perimeter. Moreover, as for the above-mentioned optical path for lightwave signal transmission, it is also desirable to consist of a resin constituent and a conductor layer of the perimeter. Moreover, as for the above-mentioned optical path for lightwave signal transmission, it is also desirable to consist of a resin constituent and an opening, and a conductor layer of these perimeters. In addition, when the above-mentioned conductor layer is formed, this conductor layer may be formed in a resin constituent and/or the whole perimeter of an opening, and may be formed in a part of perimeter.
[0201] Thus, by forming a conductor layer in the optical path for lightwave signal transmission, the scattered reflection of the light in the wall surface of the optical path for lightwave signal transmission can be reduced, and the transmission nature of a lightwave signal can be raised. The above-mentioned conductor layer may be formed from one layer, and may consist of more than two-layer. As an ingredient of the above-mentioned

conductor layer, copper, nickel, chromium, titanium, noble metals, etc. are mentioned, for example. moreover, the conductor with which the above-mentioned conductor layer sandwiched the duty as a through hole, i.e., a substrate, depending on the case — the conductor between circuits, and whose substrate and layer insulation layer were pinched — the duty which connects between circuits electrically can be achieved.

[0202] As an ingredient of the above-mentioned conductor layer, the metal which has the gloss of nickel, noble metals, etc. is desirable. It is because there is more little loss of a lightwave signal, and it is also rarer to check transmission of a lightwave signal, when the conductor layer which consists of a metal which has gloss is formed, so a lightwave signal will be certainly transmitted through the optical path for lightwave signal transmission.

[0203] Moreover, the enveloping layer and roughening layer which consist of tin, titanium, zinc, etc. may be further prepared on the above-mentioned conductor layer. It may be desirable to stop the scattered reflection of the light in the wall surface of the optical path for lightwave signal transmission depending on the classes (wavelength etc.) of lightwave signal transmitted through the optical path for lightwave signal transmission, and the transmission nature of a lightwave signal may be raised by preparing the above-mentioned enveloping layer and the above-mentioned roughening layer, and reducing the scattered reflection of the light in this wall surface. Moreover, the adhesion of the optical path for lightwave signal transmission, and a substrate and a layer insulation layer can be raised more by forming the above-mentioned roughening layer etc. in the wall surface of the optical path for lightwave signal transmission.

[0204] Moreover, the optical path for lightwave signal transmission (the part which consists of a resin constituent of the optical paths for lightwave signal transmission constituted with an opening and a resin constituent is included) and the above-mentioned conductor layer which are constituted with the above-mentioned resin constituent may be in contact with the substrate or the layer insulation layer through the roughening side. It is because it excels in adhesion with a substrate or a layer insulation layer and is harder to generate exfoliation of the optical path for lightwave signal transmission etc., when the above-mentioned optical path for lightwave signal transmission etc. has touched through the roughening side.

[0205] In the above-mentioned multilayer printed wiring board, as the above-mentioned optical path for lightwave signal transmission, the optical path for lightwave signal transmission for light-receiving, the optical path for lightwave signal transmission for luminescence, and both may be formed, and only either may be formed. Therefore, in the above-mentioned multilayer printed wiring board, two or more optical paths for lightwave signal transmission may be formed. Moreover, in the above-mentioned multilayer printed wiring board, the optical path for lightwave signal transmission may be formed for every communication link wavelength.

[0206] It is desirable especially to arrange the micro lens in the edge of the optical path for lightwave signal transmission formed in the above-mentioned multilayer printed wiring board, and the substrate for IC chip mounting and the edge of the side which counters. It is because the transmission loss of a lightwave signal can be reduced more. As the above-mentioned micro lens, the same thing as the micro lens formed in the edge of the optical path for lightwave signal transmission etc. is mentioned, for example in the substrate for IC chip mounting of the first this invention.

[0207] Moreover, to the above-mentioned multilayer printed wiring board, it is desirable to form optical waveguide. In such a multilayer printed wiring board, a lightwave signal can be transmitted through the optical path for lightwave signal transmission, and optical waveguide. The same thing as the optical waveguide formed in the multilayer printed wiring board which constitutes the device for optical communication of the third this invention as the above-mentioned optical waveguide, for example etc. is mentioned.

[0208] Moreover, it is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide like the multilayer printed wiring board which constitutes the device for optical communication of the third this invention.

[0209] moreover, the above-mentioned multilayer printed wiring board — a conductor — the conductor the circuit, the layer insulation layer, and whose above-mentioned layer insulation layer were pinched — it may be constituted including the Bahia hall which connects between circuits. The densification of a multilayer printed wiring board can be achieved by considering as such a configuration.

[0210] Moreover, as for the above-mentioned multilayer printed wiring board, it is desirable to form the solder bump for transmitting an electrical signal. Thereby, it is because an electrical signal can be transmitted between external electronic parts or an external substrate. Moreover, when the solder bump is formed, both can be stationed to the position which the photo detector and light emitting device which were mounted in the substrate for IC chip mounting, and the optical waveguide formed in the multilayer printed wiring board counter by connecting the substrate for IC chip mounting, and a multilayer printed wiring board through a solder bump. It is because a self-alignment operation of solder can be used. In addition, the same effectiveness can be acquired also when the above-mentioned substrate for IC chip mounting and the above-mentioned multilayer printed wiring board are connected through PGA or BGA.

[0211] As explained above, the device for optical communication of the fourth this invention The substrate for IC chip mounting with which the photo detector and the light emitting device were mounted although it was not limited especially when consisting of a substrate for IC chip mounting, and a multilayer printed wiring board with which an optical path for lightwave signal transmission which was mentioned above was formed, It is desirable to be constituted so that it consists of a multilayer printed wiring board with which optical waveguide was formed and a lightwave signal can be transmitted through the optical path for lightwave signal transmission between the above-mentioned photo detector and a light emitting device, and optical waveguide.
[0212] The operation gestalt of the device for optical communication of the fourth this invention is explained referring to a drawing. Drawing 4 is the sectional view showing typically 1 operation gestalt of the device for optical communication of the fourth this invention. In addition, drawing 4 shows the device for optical communication in the condition that IC chip was mounted.
[0213] As shown in drawing 4 , the device 350 for optical communication of the fourth this invention consists of the substrates 320 for IC chip mounting and multilayer printed wiring boards 300 which mounted the IC chip 340, and the substrate 320 for IC chip mounting and the multilayer printed wiring board 300 are electrically connected through the solder connection 341.
[0214] the mounting substrate 320 for IC chip — both sides of a substrate 321 — a conductor — the conductor with which laminating formation was carried out and the substrate 321 of the layer insulation layer [a circuit 324 and] 322 was pinched — circuits and the conductor whose layer insulation layer 322 was pinched — circuits are electrically connected by the through hole 329 and the Bahia hall 327, respectively. Moreover, the solder resist layer 334 equipped with the solder bump is formed in the outermost layer of drum of the mounting substrate 320 for IC chip, in addition the outermost layer of drum of a multilayer printed wiring board 300 and the side which counters is equipped with the photo detector 338 and the light emitting device 339 so that light sensing portion 338a and light-emitting part 339a may be exposed, respectively.
[0215] a multilayer printed wiring board 300 — both sides of a substrate 301 — a conductor — the conductor with which laminating formation was carried out and the substrate 301 of the layer insulation layer [a circuit 304 and] 302 was pinched — circuits and the conductor whose layer insulation layer 302 was pinched — circuits are electrically connected by the through hole 309 and the Bahia hall 307, respectively. Moreover, the optical path 361 for lightwave signal transmission which penetrates a substrate 301, the layer insulation layer 302, and the solder resist layer 314 is formed in the multilayer printed wiring board 300, and through this optical path 361 for lightwave signal transmission, it is constituted so that a lightwave signal can be transmitted between optical waveguide 319 (319a, 319b), and a photo detector 338 and a light emitting device 339. Furthermore, conductor-layer 361b is formed in a part of that wall surface, and, as for this optical path 361 for lightwave signal transmission, a part of that interior is filled up with resin constituent 361a. In the multilayer printed wiring board 300, optical waveguide 319 is formed on both sides of the substrate 301 on the substrate 320 for IC chip mounting, and the layer insulation layer 302 of the outermost layer of drum of an opposite hand, and optical waveguide 319 is equipped with the optical-path conversion mirror 319 (319a, 319b). In the device 150 for optical communication shown in drawing 4 , a photo detector and a light emitting device will be mounted in a multilayer printed wiring board and the field of the side which counters.
[0216] In addition, although the formation location of the optical waveguide in the multilayer printed wiring board shown in drawing 4 is on the layer insulation layer of an outermost layer of drum, in the multilayer printed wiring board which constitutes the substrate for IC chip mounting of the fourth this invention, the formation location of optical waveguide may not necessarily be limited here, may be between layer insulation layers, and may be on a substrate.
[0217] In such a device for optical communication of the fourth this invention, since light / electrical signal conversion is performed, the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the inside of the substrate for IC chip mounting, i.e., IC chip. moreover, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder connection — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included). Moreover, with the device for optical communication which consists of such a configuration, since it is hard to generate location gap in the photo detector mounted in the substrate for IC chip mounting, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board, it will excel in the connection dependability of a lightwave signal.
[0218] Next, how to manufacture the device for optical communication of the fourth this invention is explained. As well as the case where the device for optical communication of the third this invention is manufactured when manufacturing the above-mentioned device for optical communication, first, the substrate for IC chip mounting

and a multilayer printed wiring board can be manufactured independently, and both can be manufactured by connecting through solder etc. after that. Therefore, how to manufacture each of the substrate for IC chip mounting and a multilayer printed wiring board is explained first, and how to connect both is explained after that here.

[0219] As an approach of manufacturing the above-mentioned substrate for IC chip mounting, the approach of manufacturing the substrate for IC chip mounting of the first this invention, the same approach, etc. can be used, for example. In addition, as mentioned above, the optical path for lightwave signal transmission does not need to be formed in the substrate for IC chip mounting which constitutes the device for optical communication of the fourth this invention. Therefore, what is necessary is not to perform the process of (b) but just to form opening for optical element mounting further if needed in an approach to manufacture the substrate for IC chip mounting of the second this invention, without opening for optical paths carrying out in the process of (c), in manufacturing the substrate for IC chip mounting with which the optical path for lightwave signal transmission is not formed. Moreover, what is necessary is just to perform formation of a solder resist layer if needed, when forming the above-mentioned substrate for IC chip mounting.

[0220] As an approach of manufacturing the above-mentioned multilayer printed wiring board, the approach of performing the process of following the (1) - (5) etc. can be used, for example.

(1) Manufacture the multilayer-interconnection plate with which the breakthrough for optical paths was formed using the same approach as the process of (a) of the manufacture approach of the substrate for IC chip mounting of the second this invention, and (b).

[0221] (2) next, the conductor on the layer insulation layer of the above-mentioned multilayer-interconnection plate -- form optical waveguide in the circuit agenesis section. This optical waveguide is formed in the location which can transmit a lightwave signal through the breakthrough for optical paths. In addition, the approach of using at the process of (2) of the approach of manufacturing the multilayer printed wiring board which constitutes the device for optical communication of the fourth this invention as the formation approach of concrete optical waveguide, the same approach, etc. can be used. Moreover, an optical-path conversion mirror is formed in the optical waveguide formed here.

[0222] (3) Next, form a solder resist layer in the outermost layer of drum of the multilayer-interconnection plate in which optical waveguide was formed. What is necessary is just to form the above-mentioned solder resist layer using the approach of using at the process of (3) of the approach of manufacturing the multilayer printed wiring board which constitutes the device for optical communication of the fourth this invention, the same approach, etc. In addition, what is necessary is just to perform formation of the above-mentioned solder resist layer if needed.

[0223] (4) Next, form opening for solder bump formation, and opening for optical paths in the substrate for IC chip mounting, and the solder resist layer of the side which counters. What is necessary is just to form using the approach as the approach of using at the process of (4) of the approach of manufacturing the multilayer printed wiring board which constitutes the device for optical communication of the fourth this invention that the above-mentioned opening for solder bump formation and opening for optical paths are the same etc. Moreover, the above-mentioned opening for optical paths is formed so that it may be open for free passage to the breakthrough for optical paths formed at the process of the above (1). Moreover, after forming opening for optical paths, a resin constituent may be filled up with this process in opening for optical paths. The thing same as the above-mentioned resin constituent as the resin constituent filled up with the process of the above (1) into the breakthrough for optical paths etc. is mentioned. A resin constituent may be simultaneously filled up with this process into the breakthrough for optical paths, and opening for optical paths.

[0224] (5) Next, the multilayer printed wiring board which constitutes the device for optical communication of the fourth this invention can be manufactured by forming a solder pad, a solder bump, etc. using the approach of using at (5) of an approach and the process of (6) of manufacturing the multilayer printed wiring board which constitutes the device for optical communication of the fourth this invention, the same approach, etc.

[0225] Next, the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by the above-mentioned approach are connected, and the device for optical communication is manufactured. What is necessary is just to carry out using the approach specifically used when manufacturing the device for optical communication of the third this invention, and the same approach. Moreover, as for the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, the solder bump may be formed only in either like the case where the device for optical communication of the third this invention is manufactured, among the field which counters. It is because both are connectable also in this case.

[0226] Next, the device for optical communication of the fifth this invention is explained. The device for optical communication of the fifth this invention is a device for optical communication which consists of a substrate for IC chip mounting, and a multilayer printed wiring board. To the above-mentioned substrate for IC chip mounting

the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting forms — having — **** — the above-mentioned multilayer printed wiring board — a substrate and a conductor — it is constituted including the circuit and characterized by forming in the above-mentioned multilayer printed wiring board the optical path for lightwave signal transmission which penetrates a substrate at least.

[0227] In the device for optical communication of the fifth this invention, a lightwave signal can be transmitted through the optical path for lightwave signal transmission formed in the above-mentioned substrate for IC chip mounting, and the optical path for lightwave signal transmission formed in the above-mentioned multilayer printed wiring board.

[0228] The same thing as the substrate for IC chip mounting which will not be limited especially if the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is formed as a substrate for IC chip mounting which constitutes the device for optical communication of the fifth this invention, for example, constitutes the device for optical communication of the third this invention etc. is mentioned. The various effectiveness mentioned above can be acquired by using such a substrate for IC chip mounting.

[0229] as the multilayer printed wiring board which constitutes the device for optical communication of the fifth this invention — a substrate and a conductor — the same thing as the multilayer printed wiring board which is constituted including the circuit, will not be limited especially if the optical path for lightwave signal transmission which penetrates the above-mentioned substrate further at least is formed, for example, constitutes the device for optical communication of the third this invention etc. is mentioned. The various effectiveness mentioned above can be acquired by using such a multilayer printed wiring board.

[0230] Since the optical path for lightwave signal transmission is formed in the substrate for IC chip mounting, and the multilayer printed wiring board, in case an optical element is mounted in the substrate for IC chip mounting or optical waveguide is formed in a multilayer printed wiring board, the degree of freedom of the mounting position of an optical element or the formation location of optical waveguide will increase, and, specifically, the densification of the substrate for IC chip mounting and a multilayer printed wiring board can be achieved. This is because a free space becomes large in the design of the substrate for IC chip mounting, and a multilayer printed wiring board.

[0231] Moreover, since optical processing and a mechanical process can perform alignment of the mounting position of an optical element, or the formation location of optical waveguide on the basis of the optical path for lightwave signal transmission formed in each of the above-mentioned substrate for IC chip mounting, and a multilayer printed wiring board, an optical element and optical waveguide can be correctly mounted in a desired location. Furthermore, in the bottom of a heat treatment process or a reliability trial, the adverse effect by heat etc. cannot generate the optical path for lightwave signal transmission of a configuration as mentioned above easily.

[0232] The operation gestalt of the device for optical communication of the fifth this invention is explained referring to a drawing. Drawing 5 is the sectional view showing typically 1 operation gestalt of the device for optical communication of the fifth this invention. In addition, drawing 5 shows the device for optical communication in the condition that IC chip was mounted.

[0233] As shown in drawing 5 , the device 450 for optical communication of the fifth this invention consists of the substrates 420 for IC chip mounting and multilayer printed wiring boards 400 which mounted the IC chip 440, and the substrate 420 for IC chip mounting and the multilayer printed wiring board 400 are electrically connected through the solder connection 441.

[0234] Moreover, the optical path 451 for lightwave signal transmission which penetrates this is formed in the substrate 420 for IC chip mounting, conductor-layer 451b is formed in a part of that wall surface, and, as for this optical path 451 for lightwave signal transmission, resin constituent 451a is further filled up with the device 450 for optical communication into a part of that interior. The configuration of this substrate 420 for IC chip mounting is the same as the configuration of the substrate 220 for IC chip mounting shown in drawing 3 .

[0235] Moreover, the optical path 461 for lightwave signal transmission which penetrates a substrate 401, the layer insulation layer 402, and the solder resist layer 414 is formed in the multilayer printed wiring board 400, and through this optical path 461 for lightwave signal transmission, it is constituted so that a lightwave signal can be transmitted between optical waveguide 419, and a photo detector 438 and a light emitting device 439. Conductor-layer 461b is formed in a part of that wall surface, and, as for this optical path 461 for lightwave signal transmission, a part of that interior is further filled up with resin constituent 461a. The configuration of this multilayer printed wiring board 400 is the same as the configuration of the multilayer printed wiring board 300 shown in drawing 4 . In this device 450 for optical communication, a photo detector 438, a light emitting device 439, and optical waveguide 419 can transmit a lightwave signal through the optical path 461 for lightwave signal transmission which penetrates the optical path 451 for lightwave signal transmission which was formed in the substrate 420 for IC chip mounting, and which penetrates this, and the substrate 401 and the layer insulation

layer 402 which were formed in the multilayer printed wiring board 400, and the solder resist layer 414. Moreover, the operation gestalt of the device for optical communication of the fifth this invention may not be limited to the gestalt shown in drawing 5 , and may be a gestalt as shown in drawing 6 and 7.

[0236] Moreover, in the substrate 550 for IC chip mounting shown in drawing 6 , the photo detector 538 is mounted in the multilayer printed wiring board 500 of the substrate 520 for IC chip mounting, and the field of the side which counters, and the light emitting device 539 is mounted in the multilayer printed wiring board 500, the field of the side which counters, and the field of an opposite hand. Moreover, the optical path 551 for lightwave signal transmission which penetrates the substrate 520 for IC chip mounting is formed so that a lightwave signal can be transmitted between the optical waveguides by which the light emitting device 539 was formed in the multilayer printed wiring board 500. Conductor-layer 551b is formed in a part of the wall surface, and, as for the optical path 551 for lightwave signal transmission, a part of the interior is filled up with resin constituent 551a.

[0237] Moreover, optical waveguide is formed in the multilayer printed wiring board 500. Optical waveguide 518a for transmitting a lightwave signal between photo detectors 538 Optical waveguide 518b for being formed on both sides of the substrate 501 on the layer insulation layer 502 of the outermost layer of drum of the side near the substrate 520 for IC chip mounting, and transmitting a lightwave signal between light emitting devices 539 On both sides of the substrate 501, it is formed on the substrate 520 for IC chip mounting, and the layer insulation layer 502 of the outermost layer of drum of an opposite hand. Furthermore, the optical path 561 for lightwave signal transmission for transmitting a lightwave signal between a light emitting device 539 and optical waveguide 518b is formed in the multilayer printed wiring board 500. The optical path 561 for lightwave signal transmission is formed so that a substrate 501, the layer insulation layer 502, and the solder resist layer 514 may be penetrated, conductor-layer 561b is formed in a part of the wall surface, and a part of the interior is filled up with resin constituent 561a.

[0238] In this device 550 for optical communication, a light emitting device 539 and optical waveguide 519b can transmit a lightwave signal through the optical path 561 for lightwave signal transmission which penetrates the optical path 551 for lightwave signal transmission which was formed in the substrate 520 for IC chip mounting, and which penetrates this, and the substrate 501 and the layer insulation layer 502 which were formed in the multilayer printed wiring board 500, and the solder resist layer 514. In addition, a photo detector 538 and optical waveguide 519a can transmit a lightwave signal through opening 511a for optical paths formed in the solder resist layer of a multilayer printed wiring board 500.

[0239] Moreover, in the device 650 for optical communication shown in drawing 7 , the photo detector 638 is mounted in the multilayer printed wiring board 600 of the substrate 620 for IC chip mounting, the field of the side which counters, and the field of an opposite hand, and the light emitting device 639 is mounted in the multilayer printed wiring board 600 and the near field where it counters. Moreover, the optical path 651 for lightwave signal transmission which penetrates the substrate 620 for IC chip mounting is formed so that a lightwave signal can be transmitted between optical waveguide 618a by which the photo detector 638 was formed in the multilayer printed wiring board 600. Conductor-layer 651b is formed in a part of that wall surface, and, as for this optical path 651 for lightwave signal transmission, a part of that interior is filled up with resin constituent 651a.

[0240] Moreover, optical waveguide 618a for optical waveguide 619 being formed in the multilayer printed wiring board 600, and transmitting a lightwave signal to it between photo detectors 638 Optical waveguide 618b for being formed on both sides of the substrate 601 on the layer insulation layer of the outermost layer of drum of the side near the substrate 620 for IC chip mounting, and transmitting a lightwave signal between light emitting devices 639 On both sides of the substrate 601, it is formed on the substrate 620 for IC chip mounting, and the layer insulation layer of the outermost layer of drum of an opposite hand. Furthermore, the optical path 651 for lightwave signal transmission for transmitting a lightwave signal between a light emitting device 639 and optical waveguide 618b is formed in the multilayer printed wiring board 600. The optical path 661 for lightwave signal transmission is formed so that a substrate 601, the layer insulation layer 602, and the solder resist layer 614 may be penetrated, conductor-layer 661b is formed in a part of the wall surface, and a part of the interior is filled up with resin constituent 661a.

[0241] In this device 650 for optical communication, a light emitting device 639 and optical waveguide 619b can transmit a lightwave signal through the optical path 661 for lightwave signal transmission which penetrates the substrate 601 and the layer insulation layer 602 which were formed in the multilayer printed wiring board 600, and the solder resist layer 614. Moreover, a photo detector 638 and optical waveguide 619a can transmit a lightwave signal through the optical path 651 for lightwave signal transmission which was formed in the substrate 620 for IC chip mounting and which penetrates this.

[0242] In addition, as mentioned above, the operation gestalt of the substrate for IC chip mounting of the fifth this invention should just be a gestalt which chose suitably whether it would not necessarily be limited to the gestalt shown in drawing 5 -7, and the mounting position of a photo detector or a light emitting device, the

formation location of optical waveguide, and the optical path for lightwave signal transmission would be formed, and combined it.
[0243] In addition, although the formation location of the optical waveguide in the multilayer printed wiring board shown in drawing 5 -7 is on the layer insulation layer of an outermost layer of drum, in the multilayer printed wiring board which constitutes the substrate for IC chip mounting of the fifth this invention, the formation location of optical waveguide may not necessarily be limited here, may be between layer insulation layers, and may be on a substrate.
[0244] In such a device for optical communication of the fifth this invention, since light / electrical signal conversion is performed, the transmission distance of an electrical signal is short and can respond to a high-speed communication link more in the location near the inside of the substrate for IC chip mounting, i.e., IC chip. moreover, the electrical signal sent out from IC chip is delivery outside through an optical fiber, after being changed into a lightwave signal, as mentioned above — it is not only carried out, but it sends to a multilayer printed wiring board through a solder connection — having — the conductor of this multilayer printed wiring board — it will be sent to electronic parts, such as other IC chips mounted in the multilayer printed wiring board, through a circuit (the Bahia hall and a through hole are included). Moreover, with the device for optical communication which consists of such a configuration, since it is hard to generate location gap in the photo detector mounted in the substrate for IC chip mounting, a light emitting device, and the optical waveguide formed in the multilayer printed wiring board, it will excel in the connection dependability of a lightwave signal.
[0245] In addition, what is necessary is just to form formation of these conductor layers, and restoration of a resin constituent if needed, although a conductor layer is formed in the wall surface and, as for the optical path for lightwave signal transmission formed in the device for optical communication shown in drawing 3 -7, the interior is filled up with the resin constituent.
[0246] Next, how to manufacture the device for optical communication of the fifth this invention is explained. As well as the case where the device for optical communication of the third this invention is manufactured when manufacturing the above-mentioned device for optical communication, first, the substrate for IC chip mounting and a multilayer printed wiring board can be manufactured independently, and both can be manufactured by connecting through solder etc. after that. Therefore, how to manufacture each of the substrate for IC chip mounting and a multilayer printed wiring board is explained first, and how to connect both is explained after that here.
[0247] The approach of manufacturing the substrate for IC chip mounting which constitutes the device for optical communication of the third this invention as an approach of manufacturing the above-mentioned substrate for IC chip mounting, for example, the same approach, etc. can be used. What is necessary is just to perform formation of a solder resist layer if needed, when forming the above-mentioned substrate for IC chip mounting.
[0248] The approach of manufacturing the multilayer printed wiring board which constitutes the device for optical communication of the fourth this invention as an approach of manufacturing the above-mentioned multilayer printed wiring board, for example, the same approach, etc. can be used. What is necessary is just to perform formation of a solder resist layer if needed, when forming the above-mentioned multilayer printed wiring board.
[0249] Next, it connects with the substrate for IC chip mounting and multilayer printed wiring board which were manufactured by the above-mentioned approach, and the device for optical communication is manufactured. What is necessary is just to carry out using the approach specifically used when manufacturing the device for optical communication of the third this invention, the same approach, etc. Moreover, as for the above-mentioned substrate for IC chip mounting, and the above-mentioned multilayer printed wiring board, the solder bump may be formed only in either like the case where the device for optical communication of the third this invention is manufactured, among the field which counters. It is because both are connectable also in this case.
[0250] In addition, although IC chip mounted in the device for optical communication of the third - the fifth this invention may be mounted by wirebonding and mounted by flip chip bonding, it is desirable that it is what is mounted by flip chip bonding.
[0251]
[Example] Hereafter, this invention is further explained to a detail.
(Example 1)
A. The production bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section of the resin film for layer insulation layers, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, Dainippon Ink & Chemicals, Inc. make FENO light KA-7052) 30 weight section The ethyl diethylene glycol acetate 20 weight

section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicon system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared. After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for layer insulation layers was produced by making it dry for 10 minutes at 80-120 degrees C.
[0252] The mean particle diameter by which coating of the silane coupling agent was carried out to the preparation bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section of the resin constituent for breakthrough restoration and a front face B. By 1.6 micrometers the diameter of grain of maximum size — SiO2 spherical particle (the Adtec Corp. make —) 15 micrometers or less CRS The viscosity prepared the resin filler of 45 - 49 Pa-s at 23**1 degree C by carrying out stirring mixing of the 1101-CE170 weight section and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section for a container. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.
[0253] C. Copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.8mm or BT (bismaleimide triazine) resin of the substrate for IC chip mounting was used as the start ingredient (refer to drawing 8 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern — both sides of a substrate 21 — a conductor — the circuit 24 and the through hole 29 were formed.
[0254] (2) Wash in cold water the substrate in which the circuit 24 was formed. a through hole 29 and a conductor — NaOH (10 g/l) after drying, and NaClO2 (40 g/l), Melanism processing the water solution containing Na3 PO4 (6 g/l) — melanism — it considers as a bath (oxidation bath) — and the conductor which performs reduction processing which makes a reduction bath NaOH (10 g/l) and the water solution containing NaBH4 (6 g/l), and includes a through hole 29 — the roughening side (not shown) was formed in the front face of a circuit 24 (refer to drawing 8 (b)).
[0255] (3) the following approach after preparing the resin filler indicated to Above B — after preparation — less than 24 hours — the conductor of one side of the inside of a through hole 29, and a substrate 21 — the circuit agenesis section and a conductor — the layer of resin filler 30' was formed in the rim section of a circuit 24. That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes (refer to drawing 8 (c)).
[0256] (4) the belt sander [one side / which finished processing of the above (3) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.
[0257] thus, a through hole 29 and a conductor — the surface section of the resin filler 30 formed in the circuit agenesis section, and a conductor — the front face of a circuit 24 — flattening — carrying out — the resin filler 30 and a conductor — the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side (not shown), and the internal surface and the resin filler 30 of a through hole 29 stuck firmly through the roughening side (not shown) was obtained (refer to drawing 8 (d)). this process — the front face of the resin filler layer 30, and a conductor — the front face of a circuit 24 turns into the same flat surface.
[0258] (5) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 24, the land front face of a through hole 29, and a wall — a conductor — the roughening side (not shown) was formed in all the front faces of a circuit 24. As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0259] (6) Next, the somewhat larger resin film for layer insulation layers than the substrate produced by Above

A was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the layer insulation layer 22 was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 8 (e)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, temperature 80, and the conditions for time amount 60 seconds, and heat curing of the resin film for layer insulation layers was carried out for 30 minutes at 170 degrees C after that.

[0260] (7) Next, mind the mask with which the breakthrough with a thickness of 1.2mm was formed on the layer insulation layer 22, and it is CO2 with a wavelength of 10.4 micrometers. By gas laser, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the layer insulation layer 22 on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the breakthrough of a mask, and the conditions of one shot (refer to drawing 9 (a)).

[0261] (8) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution clearance of the epoxy resin particle which exists in the front face of the layer insulation layer 22.

[0262] (9) Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the layer insulation layer 22 by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.

[0263] (10) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the Bahia halls is included) of the layer insulation layer 22 (refer to drawing 9 (b)).

[Nonelectrolytic plating water solution]

NiSO4 0.003 mol/l tartaric acid 0.200 mol/l copper sulfate 0.030 mol/lHCHO 0.050 mol/lNaOH 0.100 mol/lalpha and alpha'-bipyridyl 100 mg/l polyethylene glycol (PEG) 0.10 g/l [nonelectrolytic plating conditions]

It is 40 minutes [0264] by whenever [30-degree C solution temperature]. (11) Next, stick a commercial photosensitive dry film on the substrate with which the thin film conductor layer (non-electrolytic copper plating film) 32 was formed, lay a mask, and it is 100 mJ/cm2. The plating resist 23 with a thickness of 20 micrometers was formed by exposing and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 9 (c)).

[0265] (12) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 9 (d)).

[Electrolysis plating liquid]

Sulfuric acid 2.24 mol/l copper sulfate 0.26 mol/l additive 19.5 ml/l (made in ATOTEKKU Japan, KAPARASHIDO HL)

[Electrolysis plating conditions]

Current density 1 A/dm 2 hours 65 Part temperature 22**2 ** [0266] (13) -- a conductor with a thickness of 18 micrometers which carries out etching processing of the thin film conductor layer under the plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution clearance and consists of a thin film conductor layer (non-electrolytic copper plating film) 32 and electrolytic copper plating film 33 further after carrying out exfoliation clearance of the plating resist 23 by NaOH 5% -- the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 10 (a)).

[0267] A roughening side (not shown) is formed in the front face of a circuit 25. (14) -- the still more nearly same etching reagent as the etching reagent used at the process of the above (5) -- using -- a conductor -- subsequently It has the opening 26 for the Bahia halls like the process of the above (6) - the above (8), and laminating formation of the layer insulation layer 22 by which the roughening side (not shown) was formed in the front face was carried out (refer to drawing 10 (b)). Then, the breakthrough 46 which penetrates a substrate 21 and the layer insulation layer 22 was formed using the drill with a diameter of 395 micrometers, and DESUMIA processing was further performed to the wall surface of a breakthrough 46 (refer to drawing 10 (c)).

[0268] (15) Next, give a catalyst to the wall surface of a breakthrough 46, and the front face of the layer

insulation layer 22 by the approach used at the process of the above (9), and the same approach. Furthermore, in the nonelectrolytic plating liquid used at the process of the above (10), and the same non-electrolytic copper plating water solution The substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 32 was formed in the front face (the internal surface of the opening 26 for the Bahia halls is included) of the layer insulation layer 22, and the wall surface of a breakthrough 46 (refer to drawing 11 (a)).
[0269] (16) Next, plating resist 23 was formed by the approach used at the process of the above (11), and the same approach, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was further formed in the plating-resist 23 agenesis section by the approach used at the process of the above (12), and the same approach (refer to drawing 11 (b)).
[0270] (17) next, the approach used at the process of the above (13) and the same approach — exfoliation of plating resist 23, and clearance of the thin film conductor layer under plating resist 23 — carrying out — a conductor — the circuit 25 (the Bahia hall 27 is included) and the conductor layer 45 were formed. furthermore, the approach used at the process of the above (2) and the same approach — oxidation reduction processing — carrying out — a conductor — the front face of a circuit 25 and the front face of a conductor layer 45 were made into the roughening side (not shown) (refer to drawing 11 (c)).
[0271] (18) Next, after being filled up with the resin constituent containing an epoxy resin and making it dry in the breakthrough 46 in which the conductor layer 45 was formed using a squeegee, flattening of the surface was carried out by buffing. Furthermore, hardening processing was performed and resin constituent layer 42a was formed (refer to drawing 12 (a)).
[0272] (19) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make —) dissolved in the methyl ethyl ketone trade name: — the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku — formation — shrine make —) trade name: — 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make —) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: — the R604 4.5 weight section — the same — a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make —) trade name: — the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make —) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent. In addition, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold).
[0273] (20) Next, the above-mentioned solder resist constituent was applied by the thickness of 30 micrometers, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of the substrate in which resin constituent layer 42a was formed, the condition for 30 minutes at 70 degrees C, and layer 34' of a solder REJISU constituent was formed in them. (Refer to drawing 12 (b)) .
[0274] (21) Subsequently, stick the photo mask with a thickness of 5mm with which the pattern of opening for solder bump formation and opening for optical paths was drawn to layer 34' of the solder resist constituent by the side of IC chip mounting, and they are 1000 mJ/cm2. It exposed by ultraviolet rays, the development was carried out with the DMTG solution, and opening with a diameter of 200 micrometers was formed. Furthermore, it carries out at 120 degrees C for 1 hour for 1 hour, heat-treats [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, the layer of a solder resist constituent is stiffened, it has the opening 47 for solder bump formation, and opening 42b for optical paths, and the solder resist layer 34 the thickness of whose is 20 micrometers was formed (refer to drawing 13 (a)). In addition, a commercial solder resist constituent can also be used as the above-mentioned solder resist constituent.
[0275] (22) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in the opening 47 for solder bump formation. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10 to 1 mol/l.), a sodium citrate (1.2x10-1 mol/l), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the solder pad 36.
[0276] (23) Next, print soldering paste to the opening 47 for solder bump formation formed in the solder resist layer 34. Furthermore, while mounting a photo detector 38 and a light emitting device 39 by carrying out a reflow

at installation and 200 degrees C, performing alignment of light sensing portion 38a of a photo detector 38 and a light emitting device 39, and light-emitting part 39a The solder bump 37 was formed in the opening 47 for solder bump formation, and the substrate for IC chip mounting was obtained (refer to drawing 13 (b)). In addition, as a photo detector 38, what consists of InGaAsP was used as a light emitting device 39 using what consists of InGaAs. In addition, the optical path for lightwave signal transmission will be constituted from a substrate for IC chip mounting manufactured by this example by a resin constituent and an opening, and the conductor layer of these perimeters.

[0277] (Example 2) In the process of (18) of an example 1, it replaced with the resin constituent containing an epoxy resin, and the substrate for IC chip mounting was obtained like the example 1 except having used the resin constituent containing polyolefine. In addition, the optical path for lightwave signal transmission will be constituted from a substrate for IC chip mounting manufactured by this example by a resin constituent and an opening, and the conductor layer of these perimeters.

[0278] (Example 3) The substrate for IC chip mounting was obtained like the example 1 except having not performed the process of (18) of an example 1, i.e., the process which forms resin constituent layer 42a. In addition, the optical path for lightwave signal transmission will be constituted from a substrate for IC chip mounting manufactured by this example by an opening and the conductor layer of the perimeter.

[0279] (Example 4) In (15) of an example 1, and the process of (16), the substrate for IC chip mounting was obtained like the example 1 on the wall surface of a breakthrough except having not formed a conductor layer. In addition, the optical path for lightwave signal transmission will be constituted from a substrate for IC chip mounting manufactured by this example by a resin constituent and the opening.

[0280] (Example 5) In (15) of an example 1, and the process of (16), a conductor layer was not formed in the wall surface of a breakthrough, but in the process of (18), it replaced with the resin constituent containing an epoxy resin, and the substrate for IC chip mounting was obtained like the example 1 except having used the resin constituent containing polyolefine. In addition, the optical path for lightwave signal transmission will be constituted from a substrate for IC chip mounting manufactured by this example by a resin constituent and the opening.

[0281] (Example 6) In (15) of an example 1, and the process of (16), a conductor layer was not formed in the wall surface of a breakthrough, but the substrate for IC chip mounting was obtained like the example 1 except having not performed the process of (18), i.e., the process which forms resin constituent layer 42a. In addition, the optical path for lightwave signal transmission will be constituted from a substrate for IC chip mounting manufactured by this example by the opening.

[0282] Thus, when the cutter cut these substrates for IC chip mounting so that it might pass along the optical path for lightwave signal transmission, and the cross section was observed about the substrate for IC chip mounting of the acquired examples 1-6, the optical path which penetrates the substrate for IC chip mounting was secured. Moreover, after having arranged the optical waveguide which becomes the edge of an opposite hand from PMMA the photo detector mounting side of the optical path for lightwave signal transmission of the substrate for IC chip mounting, attaching the detector in the edge of an opposite hand the light emitting device mounting side of the optical path for lightwave signal transmission and making a lightwave signal calculate with delivery and IC chip through the above-mentioned optical waveguide light after that, when the detector detected the lightwave signal, the desired lightwave signal was detectable. Moreover, when connection loss with a photo detector and a light emitting device, and the optical path for lightwave signal transmission was measured, the connection loss was small and was not what a problem generates in transmission of a lightwave signal.

[0283]

[Effect of the Invention] Since the optical path for lightwave signal transmission which penetrates this substrate for IC chip mounting is arranged while an optical element is mounted as mentioned above, the substrate for IC chip mounting of the first this invention can transmit the I/O signal of the above-mentioned optical element through the above-mentioned optical path for lightwave signal transmission. Moreover, when IC chip is mounted in this substrate, the distance of IC chip and an optical element is short, and it excels in the dependability of electrical signal transmission. Moreover, in the substrate for IC chip mounting of the first this invention which mounted IC chip, since electronic parts and an optical element required for optical communication can be unified, it can contribute to the miniaturization of the terminal equipment for optical communication. Moreover, in the substrate for IC chip mounting of the first this invention, when the location gap which originates in heat treatment at the time of manufacture when the surface mount of the optical element is carried out does not occur, in addition inconvenience occurs in the optical element of 1, it is [that what is necessary is to exchange only the optical element] economically advantageous.

[0284] Since the manufacture approach of the substrate for IC chip mounting of the second this invention forms the optical path for lightwave signal transmission which penetrates the substrate for IC chip mounting as

mentioned above, it can manufacture suitably the substrate for IC chip mounting of the first this invention which can transmit the I/O signal of an optical element through this optical path for lightwave signal transmission.
[0285] In the device for optical communication of the third - the fifth this invention, since the optical path for lightwave signal transmission of a mode of the substrate for IC chip mounting and the multilayer printed wiring boards mentioned above to either at least is formed, a lightwave signal can be suitably transmitted through this optical path for lightwave signal transmission. Moreover, while securing the outstanding lightwave signal transmission nature, high density wiring can be attained. Furthermore, as a substrate for IC chip mounting which constitutes the above-mentioned device for optical communication, when the substrate for IC chip mounting of the first this invention is used, the effectiveness concerning the substrate for IC chip mounting of the first this invention mentioned above and the same effectiveness can be acquired in the device for optical communication of the third - the fifth this invention.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the substrate for IC chip mounting of the first this invention.
[Drawing 2] It is the sectional view showing typically 1 another operation gestalt of the substrate for IC chip mounting of the first this invention.
[Drawing 3] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of the third this invention.
[Drawing 4] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of the fourth this invention.
[Drawing 5] It is the sectional view showing typically 1 operation gestalt of the device for optical communication of the fifth this invention.
[Drawing 6] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of the fifth this invention.
[Drawing 7] It is the sectional view showing typically 1 another operation gestalt of the device for optical communication of the fifth this invention.
[Drawing 8] It is the sectional view showing a part of manufacture approach for the substrate for IC chip mounting of the second this invention typically.
[Drawing 9] It is the sectional view showing typically a part of manufacture approach of the substrate for IC chip mounting of the second this invention.
[Drawing 10] It is the sectional view showing typically a part of manufacture approach of the substrate for IC chip mounting of the second this invention.
[Drawing 11] It is the sectional view showing typically a part of manufacture approach of the substrate for IC chip mounting of the second this invention.
[Drawing 12] It is the sectional view showing typically a part of manufacture approach of the substrate for IC chip mounting of the second this invention.
[Drawing 13] It is the sectional view showing typically a part of manufacture approach of the substrate for IC chip mounting of the second this invention.
[Description of Notations]
20 Substrate for IC Chip Mounting
21 Substrate
22 Layer Insulation Layer
24 Conductor — Circuit
27 Bahia Hall
29 Through Hole
34 Solder Resist Layer
38 Photo Detector
39 Light Emitting Device
20 Substrate for IC Chip Mounting
21 Substrate
22 Layer Insulation Layer
24 Conductor — Circuit
27 Bahia Hall
29 Through Hole
34 Solder Resist Layer
38 Photo Detector

139 Light Emitting Device
140 IC Chip
142 Optical Path for Lightwave Signal Transmission
145 Conductor Layer

[Translation done.]